(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 931 974 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
28.07.1999 Bulletin 1999/30

(51) Int. Cl.[6]: F16N 29/04, F16N 11/08

(21) Application number: 99300471.2

(22) Date of filing: 22.01.1999

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 22.01.1998 JP 2402598
26.05.1998 JP 16003398

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(54) Automatic lubricator for injection molding machine

(57) An automatic lubricator for an injection molding machine, capable of performing proper lubrication in accordance with operation environment of the injection molding machine. A lubrication interval Ls is controlled according to length of cycle time S of the injection molding machine so that the lubrication interval Ls is increased when the cycle time S is long and it is decreased when the cycle time S is short. Further, when a ball screw temperature t1 is high the lubrication interval Ls is accordingly decreased by ΔDL, and when the ball screw temperature t1 is low the lubrication interval Ls is accordingly increased by ΔDL. Also, when the ambient temperature t2 is high the operation time Tp of a lubricating pump 2 is decreased, and when the ambient temperature t2 is low the operation time Tp is increased to stabilize the lubrication quantity.

Printed by Xerox (UK) Business Services
2.16.7/3.6

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an improvement in an automatic lubricator for an injection molding machine.

2. Description of the Related Art

[0002] Movable parts of an injection molding machine, for example, a sliding part or a rotating part in an injection mechanism section, a mold clamping section, a mold thickness adjusting section and an ejector mechanism section are generally lubricated by direct supply operation of lubricant using a grease gun or the like.

[0003] An automatic lubricator which is used to perform centralized lubrication by using an electrically-driven lubricating pump connected to piping has been known conventionally. However, the conventional automatic lubricator performs only lubricating operation by automatically operating a lubricating pump at predetermined lubrication intervals. If a variation occurs in the operation environment such as cycle time and ambient temperature of the injection molding machine, the conventional lubricator cannot respond to this variation, so that excess or insufficient lubricating operation is performed undesirably.

[0004] Also, even if the lubrication intervals are fixed, the lubrication quantity per one pump operation is varied by the operation environment, so that the residual quantity of grease in a reserve tank cannot be predicted accurately. Therefore, there is a fear that the lubricant refilling work delays, resulting in hindrance to lubricating operation.

SUMMARY OF THE INVENTION

[0005] An object of the present invention is to provide an automatic lubricator for an injection molding machine, capable of performing proper lubricating operation in accordance with the operation environment of injection molding machine.

[0006] The automatic lubricator of the present invention comprises a lubricating pump for supplying lubricant to movable parts of the injection molding machine, and a controller for controlling an interval of operation of the lubricating pump or operating time of the lubricating pump for one lubrication based on at least one of cycle time of injection molding machine, temperature of the lubricated parts and ambient temperature.

[0007] In the case where the controller controls the lubricating pump to perform lubricating operation each time when set number of shots are completed and also adaptively controls the lubrication interval by adjusting the set number of shots, the controller makes the lubricating pump perform lubricating operation each time when at least one of the number of injection operations and the number of mold clamping operations reaches the set number of shots. Thereby, even when only a particular portion of injection molding machine is driven as in the case of mold clamping control operation and purging operation, running out of the lubricant can be prevented.

[0008] Also, by displaying at least one of residual quantity of the lubricant in a reserve tank, remaining tune until refilling of the lubricant is needed, and date and time when the refilling of the lubricant is needed on a display, the running out of lubricant can be prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1 is a block diagram showing a principal portion of a controller for an electrically-driven toggle type injection molding machine in accordance with one embodiment of the present invention;
FIG. 2 is a block diagram showing a principal portion of an automatic lubricator in accordance with the embodiment;
FIG. 3 is a diagram showing one example of a data file for controlling the lubrication interval based on the cycle time;
FIG. 4 is a table showing one example of a data file for correcting the lubrication interval based on the ball screw temperature;
FIG. 5 is a diagram showing one example of a data file for controlling the pump operation time based on the ambient temperature;
FIG. 6 is a flowchart showing one example of process for carrying out adaptive control of automatic lubricating operation;
FIG. 7 is a flowchart showing one example of another process for carrying out adaptive control of automatic lubricating operation; and
FIG. 8 is a flowchart showing one example of another process for carrying out adaptive control of automatic lubricating operation.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] One embodiment in which the present invention is applied to an electrically-driven toggle type injection molding machine will be described below with reference to the accompanying drawings.

[0011] FIG. 1 is a block diagram showing a principal portion of a controller 10 for an electrically-driven toggle type injection molding machine, which is also used as a control section for an automatic lubricator, and FIG. 2 is a block diagram showing a principal portion of an automatic lubricator 1 adaptively controlled by the controller 10.

[0012] As shown in FIG. 1, the controller 10 has a CNC CPU 25 which is a microprocessor for numerical control, a PC CPU 18 which is a microprocessor for programmable controller, a servo CPU 20 which is a microprocessor for servo control, and a pressure monitor CPU for performing sampling process of pressure by detecting an injection pressure and screw back pressure from a pressure detector located on the body side of injection molding machine via an A/D converter 16. In this controller 10, information transfer can be effected between the microprocessors by selecting the mutual input/output via a bus 22.

[0013] The PC CPU 18 is connected with a ROM 13 which stores a sequence program for controlling the sequence operation of injection molding machine, a program necessary for adaptive control of the automatic lubricator 1, and the like, and a RAM 14 which is used for temporary storage of arithmetic data etc. The CNC CPU 25 is connected with a ROM 27 which stores a program for controlling the injection molding machine as a whole, and a RAM 28 which is used for temporary storage of arithmetic data etc.

[0014] Also, each of the servo CPU 20 and the pressure monitor CPU 17 is connected with a ROM 21 storing a control program for servo control only and a RAM 19 used for temporary storage of data, and a ROM 11 storing a control program regarding sampling process etc. of injection pressure and a RAM 12 used for temporary storage of data, respectively.

[0015] Further, the servo CPU 20 is connected with servo amplifiers 15 for driving servomotors of axes for mold clamping, for injection, for screw rotation, for ejector, etc. based on a command from the CPU 20. The output from a position and velocity detector installed on the servomotor of each axis is returned to the servo CPU 20. The present position of each axis is calculated by the servo CPU 20 based on the feedback signal from the position and velocity detector, and updated and stored in the present position storage register for each axis.

[0016] FIG. 1 shows only a servo amplifier 15 for injection, a servomotor M, and a position and velocity detector P. The configurations for all axes for mold clamping, for ejector, etc. are equal to this. However, for screw rotation only, the present position need not be detected, and the velocity has only to be detected.

[0017] An interface 23 is an element for sending an ON/OFF control signs to a lubricating pump 2 provided on the automatic lubricator 1. In addition, the temperature measurement values from a temperature detector 8 installed to a lubrication section on the injection molding machine side, for example, a ball screw for driving a toggle, and a thermometer 9 disposed at a molding work place where the injection molding machine is installed are input to the interface 23.

[0018] A manual data input device 29 with display is connected to the bus 22 via a CRT display circuit. The selection of graph display screen and function menu, the input operation of various data, and the like can be performed with this input device 29. The input device 29 is provided with ten keys for inputting numerical data and various function keys.

[0019] A nonvolatile memory 24 is a molding data storage memory for storing the molding conditions, various setting values, parameters, macro variables, and the like regarding the injection molding work. The nonvolatile memory 24 also stores a data file necessary for adaptive control of the automatic lubricator 1.

[0020] Also, the nonvolatile memory 24 stores the data regarding the operation state of injection molding machine, for example, the data for each shot as to the aforementioned injection pressure and screw back pressure and the cycle time for each shot, as in the prior art.

[0021] By the above-described configuration, the PC CPU 18 controls the sequence operation of the whole injection molding machine, and the CNC CPU 25 distributes movement commands to the servomotors of axes based on the operation program in the ROM 27, the molding conditions in the nonvolatile memory 24, and the like. Also, the servo CPU 20 carries out servo control such as position loop control, velocity loop control, and current loop control, as in the prior art, based on the movement command distributed to each axis and the feedback signal of position and velocity detected by the position and velocity detector, executes a so-called digital servo process, and drives the servomotor of each axis.

[0022] As shown in FIG. 2, the automatic lubricator 1 adaptively controlled by the PC CPU 18 of the controller 10 includes a lubricating pump 2 formed integrally with a reserve tank, main pipes 3 for introducing grease, which is delivered from the lubricating pump 2, to the injection molding machine side, junctions 4 connected to the main pipe 3, distributors 5 provided on the junction 4, branch pipes 6 for introducing grease, which is distributed by the distributor 5, to a lubricating unit 7 at each part of injection molding machine, and lubricating units 7 provided in the sliding section and rotating section of injection molding machine to be lubricated.

[0023] The lubricating unit 7 is made up of, for example, a sliding sleeve interposed between a movable platen and a tie bar of injection molding machine, a pivotally mounting sleeve provided in a rocking section of toggle mechanism, and a socket installed on a ball screw for injection or for driving the toggle. As described above, in this embodiment, the temperature detector 8 is installed to the lubricating unit 7 formed by the socket installed to the ball screw for driving the toggle.

[0024] The lubricating unit 7 has various sizes, large and small, depending on the installation position thereof. Also, since there is a difference in the substantial number of sliding motions and rotating motions per time, the distribution percentage of grease to each lubricating unit 7 can freely be set manually by each distributor 5 provided on each junction 4.

[0025] Next, the lubricating operation of the automatic lubricator 1 will be described with reference to a flowchart (FIG. 6) for automatic lubrication process executed repeatedly for each predetermined cycle by the PC CPU 18 of the controller 10.

[0026] The PC CPU 18, which has started the automatic lubrication process for each predetermined cycle, first determines whether or not a flag F1 showing automatic lubricating operation being executed is set (Step S1), and whether or not a flag F2 showing a waiting state of refilling of grease to the reserve tank is set (Step S2). Since the automatic lubricating operation is not being performed at the initial stage after the start of process, and the reserve tank is full of grease, neither flag is set. Therefore, the determination results of Steps S1 and S2 are No.

[0027] Then, the PC CPU 18 determines whether automatic operation is selected or manual operation (including semi-automatic operation) is selected as the operation mode of injection molding machine (Step S3). If automatic operation is not selected, the automatic lubrication process of this cycle is finished without being further executed. Therefore, in the case of manual operation mode, substantial automatic lubrication process is not executed.

[0028] On the other hand, if automatic operation is selected, the PC CPU 18 first increases the value of a counter L forming a timer by 1, and updates and stores the elapsed time from the previous automatic lubricating operation (Step S4). Then, the PC CPU 18 reads the present value t1n of ball screw temperature via the temperature detector 8 and the present value t2n of ambient temperature via the thermometer 9, and also reads the present value Sn of cycle tune of molding work stored in the nonvolatile memory 24 (Step S5), and adds these values to integrating registers t1, t2 and S, respectively (Step S6).

[0029] Next, the PC CPU 18 determines whether or not the present value of the counter L reaches the initial setting value Ls of lubrication interval (Step S7). If the present value does not reach Ls, the automatic lubricating operation need not be performed, so that the automatic lubrication process of this cycle is finished without being further executed.

[0030] Until the present value of the counter L reaches the initial setting value Ls of lubrication interval, only the processes of Steps S1 to S7 are repeatedly executed in the same manner as described above.

[0031] During the time when such processes are repeatedly executed, when the fact that the present value of the counter L has reached the initial setting value Ls of lubrication interval is detected by the determination process of Step S7, and it is verified that the lubrication time has come, the PC CPU 18 divides each value in the integrating registers t1, t2 and S by the present value of the counter L, and thereby determines a mean value t1 of ball screw temperature and a mean value t2 of ambient temperature during the time from the previous automatic lubricating operation to the present time, and a mean value S of cycle time of molding work (Step S8). Further, the PC CPU 18 determines a correction value ΔDL of lubrication interval corresponding to the mean value t1 of ball screw temperature and operation tune Tp of the lubricating pump 2 corresponding to the mean value t2 of ambient temperature (Step S9), and adds the correction value ΔDL to the lubrication interval Ls to correct the value of lubrication interval Ls to a value Ls considering the cycle time S and the ball screw temperature t1 of injection molding machine (Step S10).

[0032] FIGS. 3, 4 and 5 each show an example of a data file in the nonvolatile memory 24 used for the process of Step S9.

[0033] FIG. 3 shows a data file showing a relationship between the mean time S of cycle time and the lubrication interval Ls. In this embodiment, the lubrication interval Ls is set so that the lubrication interval Ls decreases as the cycle time S is shortened and the consumption of grease becomes heavy. Also, the lubrication interval Ls is set so that even when the cycle time S is long, the minimum necessary lubricating operation is performed at some intervals, considering the deterioration, evaporation, etc. of grease.

[0034] FIG. 4 shows a data file showing a relationship between the ball screw temperature t1 representing the temperature of grease and the correction value ΔDL. The correction value ΔDL is set so that when the ball screw temperature t1 is low and the load of injection molding machine is low the lubrication interval Ls is increased, and when the ball screw temperature t1 is high and the load of injection molding machine is high, the lubrication interval Ls is decreased.

[0035] FIG. 5 shows a data file showing a relationship between the ambient temperature t2 and the operation time Tp of the lubricating pump 2. The pump operation time Tp is set so that when the ambient temperature t2 is low and the viscosity of grease is high, the pump operation time Tp is increased, and when the ambient temperature t2 is high and the viscosity of grease is low, the pump operation time Tp is decreased.

[0036] The PC CPU 18, which has reset the values of the pump operation time Tp and the lubrication interval Ls, gives an operation command to the lubricating pump 2 to start the delivery of grease (Step S11), resets the values of the counter L and integrating registers t1, t2 and S (Steps S12 and S13), and sets the flag F1 showing automatic lubricating operation being executed (Step S14), by which the automatic lubrication process of this cycle is finished.

[0037] As the result that the flag F1 is set, in the automatic lubrication process of the next cycle, the determination result of Step S1 becomes Yes. Then, it is determined whether or not the value of the counter L reaches the operation time Tp of the lubricating pump 2 (Step S15). At the present stage immediately after the start of operation of the lubricating pump 2, the determi-

nation result is No. Therefore, the PC CPU 18 increases the value of the counter L by 1 (Step S28), by which the automatic lubrication process of this cycle is finished.

[0038] Thereafter, only the processes of Steps S1, S15 and S28 are repeatedly executed for each predetermined cycle. During this time, if it is judged in the determination process of Step S15 that the value of the counter L has reached the operation time Tp of the lubricating pump 2, the PC CPU 18 stops the operation of the lubricating pump 2 (Step S16), resets the counter L and the flag F1 (Step S17), and subtracts the quantity g' of grease delivered by one automatic lubricating operation from the present value of a grease residual quantity storage register g (initial value is gf) storing the residual quantity of grease in the reserve tank to update the value of residual quantity g of grease in the reserve tank (Step S18).

[0039] The PC CPU 18 divides the present value g of residual quantity of grease by the delivery quantity g' (setting value) of grease for one cycle to determine the number of automatic lubricating operations [g/g'] capable of being executed with the grease remaining in the reserve tank, multiplies this value by the present value Ls of lubrication interval to determine the remaining time [(g/g') x Ls] for which normal automatic lubricating operation can be continued without the refilling of grease to the reserve tank, and displays the remaining time together with the present value g of residual quantity of grease on a display of the manual data input device 29 to tell the effect to the operator (Step S19).

[0040] The operation time Tp of the lubricating pump 2 is set considering the change in viscosity of grease caused by the fluctuations in the ambient temperature t2. Therefore, the quantity of grease actually delivered by one automatic lubricating operation is kept at a substantially fixed value approximate to the setting value g', and the residual quantity g of grease in the reserve tank and the remaining time [(g/g') x Ls] can be calculated exactly as compared with the conventional lubricator.

[0041] If the present time is read from a clock built in the controller 10, [(g/g') x Ls] is added to this value, and the sum is displayed, predicted date and time when the refilling of grease is needed can be displayed in place of the allowance time until the refilling of grease.

[0042] Next, the PC CPU 18 determines whether or not the residual quantity g of grease in the reserve tank has decreased to a degree such that the refilling of grease is needed, for example, whether or not the residual quantity g is not larger than 10% of the maximum storage quantity gf in the reserve tank (Step S20). If the residual quantity g of grease exceeds 10% of the maximum storage quantity gf, the refilling work of grease to the reserve tank need not be performed for a while, so that the automatic lubrication process of this cycle is finished without being further executed.

[0043] Thereupon, when there is a margin for residual quantity g of grease in the reserve tank, that is, when the determination result of Step S20 is No, the display of the residual quantity g of grease in the reserve tank and the remaining time [(g/g') x Ls] is only updated by the processes of Steps S18 and S19 and displayed.

[0044] Since both of the flags F1 and F2 are set at 0 from the next cycle, the processes of Steps S1 to S7 are repeatedly executed for each predetermined cycle in the same manner as described before. If the value of the counter L exceeds the lubrication interval Ls, the processes of Steps S8 to S14 are executed, and the processes of Steps S1, S15 and S28 are repeatedly executed until the value of the counter L reaches the operation time Tp of the lubricating pump 2. If L $\geq^3$ Tp, the processes of Steps S16 to S20 are executed. Thereafter, these processes are repeatedly executed, and automatic lubricating operation is repeatedly performed for the pump operation time Tp considering the ambient temperature t2 for each lubrication interval Ls considering the cycle time S and the ball screw temperature t1 of injection molding machine.

[0045] If the determination result of Step S20 becomes Yes during the time when the automatic lubricating operation is repeatedly performed, and it is judged that the residual quantity g of grease in the reserve tank has decreased to a degree such that the refilling of grease is needed, the PC CPU 18 displays an alarm message that the reserve tank should be refilled with grease on the display of the manual data input device 29 to tell the effect to the operator (Step S21), and sets the flag F2 showing a waiting state of refilling of grease to the reserve tank (Step S22).

[0046] Next, the PC CPU 18 determines whether or not the refilling of grease to the reserve tank has been finished (Step S23). Since the refilling work of grease by the operator is not finished in the same process cycle, the determination result is No. Therefore, the PC CPU 18 executes the processes of Steps S3 to S7 in the same cycle in the same manner as described before, and then finishes the automatic lubrication process of this cycle.

[0047] As the result that the flag F2 is set, in the automatic lubrication process in the next and subsequent cycle, the processes of Steps S1, S2, S23, and S3 to S7 are repeatedly executed, and the PC CPU 18 enters a waiting state for waiting the refilling of grease to the reserve tank. During this time, the determination process of Step S23 is repeatedly executed, and whether or not the reserve tank has been refilled with grease is checked by the PC CPU 18.

[0048] Even if an alarm message that the reserve tank should be refilled with grease is displayed on the display of the manual data input device 29, about 10% of the maximum storage quantity gf of grease remains in the reserve tank. Therefore, several automatic lubricating operations can be performed continuously in this state. Thereupon, when the next lubrication interval Ls comes before the operator refills the reserve tank with grease, the processes of Steps S8 to S14, S16 to S22, and S28 are repeatedly executed in the same manner as

described before, and the automatic lubricating operation for the injection molding machine is performed without trouble.

[0049] Since the alarm message is displayed in the state in which some quantity of grease remains in the reserve tank, even if a variation occurs in the actual delivery quantity of grease used for one automatic lubricating operation, for example, even if the actual delivery quantity of grease becomes larger than the estimated value g', the automatic lubricating operation can be performed during the time until the reserve tank is refilled with grease, so that the actual lubricating operation is not hindered.

[0050] The operator, who has checked the alarm message of refilling of grease during this time, refills the reserve tank with grease and operates a refill finish button on the manual data input device 29. Then, the PC CPU 18 detects this operation in the determination process of Step S23, and updates the value of the register g storing the residual quantity of grease to the maximum storage quantity gf (Step S24). Next, the PC CPU 18 releases the alarm display on the display of the manual data input device 29 (Step S25), and resets the flag F2 showing the waiting state of refilling of grease to the reserve tank (Step S26). Thereafter, the PC CPU 18 determines the present value g of residual quantity of grease and the remaining time [(g/g') x Ls] for which normal lubricating operation can be continued without refilling of grease, and displays the present value g of residual quantity of grease and the remaining time [(g/g') x Ls] on the display of the manual data input device 29 (Step S27), and executes the processes of Steps S3 to S7 in the same manner as described before, by which the automatic lubrication process of this cycle is finished.

[0051] If it is judged in the determination process of Step S7 that the value of the counter L counts the lubrication interval Ls in the automatic lubrication process in the next and subsequent cycle, on each occasion the lubricating pump 2 is operated for the operation time Tp according to the ambient temperature, so that the automatic lubricating operation is performed. Also, if it is judged in the process of Step S20 that the quantity g of grease in the reserve tank decreases and becomes smaller than 10% of the total quantity, the alarm message of refilling of grease is displayed again. By referring to this alarm message, the operator refills the reserve tank with grease. Thereafter, this operation is repeated.

[0052] The above is a description of an example as one embodiment in which the quantity of grease delivered by one automatic lubricating operation is kept at a substantially constant value by controlling the operation time Tp of the lubricating pump 2 based on the ambient temperature t2. However, a pressure sensor for detecting the rise in pressure of grease may be installed on the terminal lubricating unit 7 so that the operation of the lubricating pump 2 is stopped at the stage at which the detected pressure reaches a setting value. In this case, the calculation process of the operation time Tp in Step S9 is unnecessary. It is necessary only that after the lubricating pump 2 is operated in the process of Step S11, the operation of the lubricating pump 2 be stopped by determining in the process of Step S11 whether or not the detected pressure of the pressure sensor has reached the setting value. Naturally, the process of Step S8 is unnecessary.

[0053] In particular, in the case where not only the ambient temperature varies, but various lands of grease with different viscosity etc. are used to test its suitability for a lubricant for injection molding machine, that is, in the case where conditions other than ambient temperature have an effect on the lubrication state, it is more reliable that the lubricating pump 2 is operated until the rise in pressure of grease on the terminal lubricating unit 7 is detected.

[0054] Also, in the above-described embodiment, the mean value of the cycle time S, ball screw temperature t1, and ambient temperature t2 has been determined. However, the mean value is not determined, and the lubrication interval Ls, the correction value ΔDL therefor, and the operation time Tp of the lubricating pump 2 may be determined based on the cycle time S, ball screw temperature t1, and ambient temperature t2 at the stage at which the counter L reaches the lubrication interval Ls. In this case, the processes of Steps S6 and S8 are unnecessary.

[0055] In the above-described embodiment, temperature has been measured with the temperature detector 8 installed on the lubricating unit 7 formed by the socket installed to the ball screw to represent the load of injection molding machine. However, the load (calorific value) of injection molding machine may be measured with a temperature detector installed on the lubricating unit 7 of the socket of ball screw for injection mechanism, the pivotally mounting sleeve provided in the rocking section of toggle mechanism, or the like. Also, temperature detectors may be arranged at several places to measure the load of injection molding machine by averaging the detected values.

[0056] Next, another embodiment will be described with reference to a flowchart for automatic lubrication process shown in FIG.7, in which embodiment, a counter C1 for counting the number of mold clamping operations, a counter C3 for counting the number of injections, and a temperature detector 30 for detecting the temperature of injection ball screw are provided on the injection molding machine side, and the lubrication interval is adaptively controlled by controlling a setting value Cs of the number of shots by which the lubricating operation is performed.

[0057] Although in the above-described embodiment, the lubrication interval has been controlled by the setting value Ls of time, this embodiment differs from the above-described embodiment in that the lubrication interval is controlled by the setting value Cs of the sub-

stantial number of shots. Further, as in the case of mold clamping control work and purging work, considering a case where only a particular portion of injection molding machine such as an injection mechanism or a mold clamping mechanism is driven, both of the number of injections C3 and the number of mold clamping operations C1 are detected as the number of shots, and when at least one of the two reaches the setting value Cs of the number of shots, lubrication is effected, by which the running out of grease due to the driving of the particular portion is prevented.

[0058] The PC CPU 18, which has started the automatic lubrication process for each predetermined cycle, first determines whether or not a flag F1 showing automatic lubricating operation being executed is set (Step T1), and whether or not a flag F2 showing a waiting state of refilling of grease to the reserve tank is set (Step T2). Since the automatic lubricating operation is not being performed at the initial stage after the start of process, and the reserve tank is full of grease, neither flag is set. Therefore, the determination results of Steps T1 and T2 are No.

[0059] Then, the PC CPU 18 determines whether automatic operation is selected or manual operation (including semi-automatic operation) is selected as the operation mode of injection molding machine (Step T3). If automatic operation is not selected, the automatic lubrication process of this cycle is finished without being further executed. The values of the counter C1 for counting the number of mold clamping operations and the counter C3 for counting the number of injections are automatically counted up by one reciprocating operation of the mold clamping mechanism or one reciprocating operation of the injection screw independently of automatic operation and manual operation (including semi-automatic operation).

[0060] On the other hand, if automatic operation is selected, the PC CPU 18 first increases the value of the counter L forming the timer by 1, and updates and stores the elapsed time from the previous automatic lubricating operation (Step T4). Then, the PC CPU 18 reads the values of the molding clamping counter C1 and the injection counter C3 (Step T5), and determines whether or not the present value of the mold clamping counter C1 reaches the setting value Cs of the number of shots by which the lubricating operation is performed (Step T6). If the determination result is No, the PC CPU 18 further determines whether or not the present value of the injection counter C3 reaches the setting value Cs (step T7).

[0061] If the present values of both counters do not reach the setting value Cs, automatic lubricating operation need not yet be performed at this stage, so that the PC CPU 18 finishes the automatic lubrication process of this cycle without further executing it.

[0062] Thereafter, until the present value of the mold clamping counter C1 or that of the injection counter C3 reaches the initial setting value Cs of lubrication interval, only the processes of Steps T1 to T7 are repeatedly executed.

[0063] If during the time when such processes are repeatedly executed, it is judged in the determination process of Step T6 that the present value of the mold clamping counter C1 has reached the initial setting value Cs of the number of shots at the lubrication interval, the PC CPU 18 reads the present value t1 of the mold clamping ball screw temperature via the temperature detector 8 for the mold clamping ball screw (Step T11), determines a correction value ΔDCs1 of lubrication interval corresponding to the present value t1 of the mold clamping ball screw temperature by referring to the data file in the nonvolatile memory 24 (Step T12), and stores this value in a correction value storage register ΔDCs (Step T13).

[0064] If the correction value ΔDCs1 is replaced with ΔDL, the logical structure of data file regarding the mold clamping ball screw temperature t1 is substantially the same as that of the aforementioned data file shown in FIG. 4. In this embodiment, however, since the lubrication interval is controlled on the basis of the number of executions of shot, in the correction value column of data file corresponding to FIG. 4, the correction value ΔDCs1 (integral number) of the number of executions of shot, not the correction value ΔDL of time, is stored.

[0065] On the other hand, during the time when the processes of Steps T1 to T7 are repeatedly executed, if it is judged in the determination process of Step T7 that the present value of the injection counter C3 has reached the initial setting value Cs of the number of shots at the lubrication interval, the PC CPU 18 reads the present value t3 of the injection ball screw temperature via the temperature detector 30 for the injection ball screw (Step T8), determines a correction value ΔDCs3 of lubrication interval corresponding to the present value t3 of the injection ball screw temperature by referring to the data file in the nonvolatile memory 24 (Step T9), and stores this value in a correction value storage register ΔDCs (Step T10).

[0066] The logical structure of the data file regarding the injection ball screw temperature t3 is also substantially the same as that of the data file shown in FIG. 4. In this embodiment, however, since the lubrication interval is controlled on the basis of the number of executions of shot, in the correction value column of data file corresponding to FIG. 4, the correction value ΔDCs3 (integral number) of the number of executions of shot, not the correction value ΔDL of time, is stored as in the case of the aforementioned data file of mold clamping ball screw temperature t1.

[0067] The CP CPU 18, which has determined the correction value ΔDCs of lubrication interval based on the temperature of ball screw having the larger number of operations in the process of Step T13 or T10, reads the present value t2 of ambient temperature via the thermometer 9 (Step T14), and determines the correction value ΔDCs' of lubrication interval for the ambient

temperature t2 and the value of operation time Tp of the lubricating pump 2 corresponding to the ambient temperature t2 (Step T15).

[0068] The structure of the data file storing the correction value ΔDCs' (integral number) of lubrication interval for the ambient temperature t2 is as shown in FIG. 4 like the logical structure of the data file regarding the mold clamping ball screw temperature t1 and injection ball screw temperature t3. Also, the structure of the data file storing the operation time Tp of the lubricating pump 2 corresponding to the ambient temperature t2 is exactly the same as that shown in the aforementioned FIG. 5.

[0069] Next, the CP CPU 18 adds the correction value ΔDCs of lubrication interval based on the ball screw temperature and the correction value ΔDCs' of lubrication interval based on the ambient temperature t2 to the present setting value Cs of the number of shots for carrying out lubrication to correct the setting value Cs of the number of shots for carrying out lubrication to a value Cs considering the temperature t1 or t3 of ball screw having the larger number of operations (Step T16).

[0070] As described above, when the value of the injection counter C3 first reaches the setting value Cs by driving the injection mechanism only, the value of the injection ball screw temperature t3 is considered. Also, when the value of the mold clamping counter C1 first reaches the setting value Cs by driving the mold clamping mechanism only, the value of the mold clamping ball screw temperature t1 is considered.

[0071] Then, the CP CPU 18 stores the present value of the counter L, that is, the required time from the previous automatic lubricating operation to the present automatic lubricating operation in a register Ls (Step T17), gives an operation command to the lubricating pump 2 to start the delivery of grease (Step T18), resets the values of the counters L, C1 and C3 (Steps T19 and T20), and sets the flag F1 showing automatic lubricating operation being executed (Step T21), by which the automatic lubrication process of this cycle is finished.

[0072] As the result that the flag F1 is set, in the automatic lubrication process of the next cycle, the determination result of Step T1 becomes Yes. Then, it is determined whether or not the value of the counter L reaches the operation time Tp of the lubricating pump 2 (Step T22). At the present stage immediately after the start of operation of the lubricating pump 2, the determination result is No. Therefore, the PC CPU 18 increases the value of the counter L by 1 (Step T35), by which the automatic lubrication process of this cycle is finished.

[0073] Thereafter, only the processes of Steps T1, T22 and T35 are repeatedly executed for each predetermined cycle. During this time, if it is judged in the determination process of Step T22 that the value of the counter L has reached the operation time Tp of the lubricating pump 2, the PC CPU 18 stops the operation of the lubricating pump 2 (Step T23), resets the counter L and the flag F1 (Step T24), and subtracts the quantity g' of grease delivered by one automatic lubricating operation from the present value of a grease residual quantity storage register g (initial value is gf) storing the residual quantity of grease in the reserve tank to update the value of residual quantity g of grease in the reserve tank (Step T25).

[0074] The PC CPU 18 divides the present value g of residual quantity of grease by the delivery quantity g' (setting value) of grease for one cycle to determine the number of automatic lubricating operations [g/g'] capable of being executed with the grease remaining in the reserve tank, multiplies this value by the value Ls of time corresponding to the substantial lubrication interval to determine the remaining time [(g/g') x Ls] for which normal automatic lubricating operation can be continued without the refilling of grease to the reserve tank, and displays the remaining time together with the present value g of residual quantity of grease on the display of the manual data input device 29 to tell the effect to the operator (Step T26).

[0075] The operation time Tp of the lubricating pump 2 is set considering the change in viscosity of grease caused by the fluctuations in the ambient temperature t2. Therefore, the quantity of grease actually delivered by one automatic lubricating operation is kept at a substantially fixed value approximate to the setting value g', and the residual quantity g of grease in the reserve tank and the remaining time [(g/g') x Ls] can be calculated exactly as compared with the conventional lubricator.

[0076] If the present time is read from the clock built in the controller 10, [(g/g') x Ls] is added to this value, and the sum is displayed, predicted date and time when the refilling of grease is needed can be displayed in place of the allowance time until the refilling of grease.

[0077] Next, the PC CPU 18 determines whether or not the residual quantity g of grease in the reserve tank has decreased to a degree such that the refilling of grease is needed, for example, whether or not the residual quantity g is not larger than 10% of the maximum storage quantity gf in the reserve tank (Step T27). If the residual quantity g of grease exceeds 10% of the maximum storage quantity gf, the refilling work of grease to the reserve tank need not be performed for a while, so that the automatic lubrication process of this cycle is finished without being further executed.

[0078] Thereupon, when there is a margin for residual quantity g of grease in the reserve tank, that is, when the determination result of Step T27 is No, the display of the residual quantity g of grease in the reserve tank and the remaining time [(g/g') x Ls] is only updated by the processes of Steps T25 and T26 and displayed.

[0079] Since both of the flags F1 and F2 are set at 0 from the next cycle, the processes of Steps T1 to T7 are repeatedly executed for each predetermined cycle in the same manner as described before. If the value of the counter C1 or C3 exceeds the setting value Cs of the number of shots corresponding to the lubrication interval, the processes of Steps T11 to ST13 or Steps

T8 to T10 and Steps T14 to T21 are executed, and the processes of Steps T1, T22 and T35 are repeatedly executed until the value of the counter L reaches the operation time Tp of the lubricating pump 2. If $L \geq^3 Tp$, the process of Step T27 is executed. Thereafter, these processes are repeatedly executed, the temperature t1 or t3 of ball screw having the larger number of operations tees precedence, and automatic lubricating operation is repeatedly performed for the pump operation time Tp considering the ambient temperature t2 for each number of shots Cs of lubrication interval considering the ambient temperature t2.

[0080] If the determination result of Step T27 becomes Yes during the time when the automatic lubricating operation is repeatedly performed, and it is judged that the residual quantity g of grease in the reserve tank has decreased to a degree such that the refilling of grease is needed, the PC CPU 18 displays an alarm message that the reserve tank should be refilled with grease on the display of the manual data input device 29 to tell the effect to the operator (Step T28), and sets the flag F2 showing a waiting state of refilling of grease to the reserve tank (Step T29).

[0081] Next, the PC CPU 18 determines whether or not the refilling of grease to the reserve tank has been finished (Step T30). Since the refilling work of grease by the operator is not finished in the same process cycle, the determination result is No. Therefore, the PC CPU 18 executes the processes of Steps T3 to T7 in the same cycle in the same manner as described before, and then finishes the automatic lubrication process of this cycle.

[0082] As the result that the flag F2 is set, in the automatic lubrication process in the next and subsequent cycle, the processes of Steps T1, T2, T30, and T3 to T7 are repeatedly executed, and the PC CPU 18 enters a waiting state for waiting the refilling of grease to the reserve tank. During this time, the determination process of Step T30 is repeatedly executed, and whether or not the reserve tank has been refilled with grease is checked by the PC CPU 18.

[0083] Even if an alarm message that the reserve tank should be refilled with grease is displayed on the display of the manual data input device 29, about 10% of the maximum storage quantity gf of grease remains in the reserve tank. Therefore, several automatic lubricating operations can be performed continuously in this state. Thereupon, when the next lubrication interval Ls comes before the operator refills the reserve tank with grease, the processes of Steps T11 to T13 or T7 to T10, and Steps T14 to T21 and T23 to T29 and T35 are repeatedly executed in the same manner as described before, and the automatic lubricating operation for the injection molding machine is performed without trouble.

[0084] Since the alarm message is displayed in the state in which some quantity of grease remains in the reserve tank, even if a variation occurs in the actual delivery quantity of grease used for one automatic lubricating operation, for example, even if the actual delivery quantity of grease becomes larger than the estimated value g', the automatic lubricating operation can be performed during the time until the reserve tank is refilled with grease, so that the actual lubricating operation is not hindered.

[0085] The operator, who has checked the alarm message of refilling of grease during this time, refills the reserve tank with grease and operates the refill finish button on the manual data input device 29. Then, the PC CPU 18 detects this operation in the determination process of Step T30, and updates the value of the register g storing the residual quantity of grease to the maximum storage quantity gf (Step T31). Next, the PC CPU 18 releases the alarm display on the display of the manual data input device 29 (Step T32), and resets the flag F2 showing the waiting state of refilling of grease to the reserve tank (Step T33). Thereafter, the PC CPU 18 determines the present value g of residual quantity of grease and the remaining time [(g/g') x Ls] for which normal lubricating operation can be continued without the refilling of grease, and displays the present value g of residual quantity of grease and the remaining time [(g/g') x Ls] on the display of the manual data input device 29 (Step T34), and executes the processes of Steps T3 to T7 in the same manner as described before, by which the automatic lubrication process of this cycle is finished.

[0086] If it is judged in the determination process of Step T6 or T7 that the value of the counter C1 or C3 counts the number of shots Cs of lubrication interval in the automatic lubrication process in the next and subsequent cycle, on each occasion the lubricating pump 2 is operated for the operation time Tp according to the ambient temperature, so that the automatic lubricating operation is performed. Also, if it is judged in the process of Step T27 that the quantity g of grease in the reserve tank decreases and becomes smaller than 10% of the total quantity, the alarm message of refilling of grease is displayed again. By referring to this alarm message, the operator refills the reserve tank with grease. Thereafter, this operation is repeated.

[0087] According to this embodiment, both of the values of the mold clamping counter C1 and the injection counter C3 are detected as the substantial number of shots, and lubricating operation is performed at the stage at which either one of these values reaches the setting value Cs of the number of shots for carrying out lubrication. Therefore, as in the case of mold clamping control work and purging work by manual operation, even when only a particular portion of injection molding machine such as the injection mechanism or the mold clamping mechanism is driven, the occurrence of running out of grease in the particular portion can be prevented.

[0088] According to the present invention, since the lubricating conditions is adaptively controlled according to the operation environment of injection molding

machine, even if the cycle time and load of injection molding machine, ambient temperature, and the like are varied, proper automatic lubricating operation can be performed, and the injection molding machine can be used in a satisfactory condition for a long period of time.

[0089] Also, since the quantity of grease consumed for one automatic lubricating operation is kept constant by the proper lubricating conditions, the residual quantity of grease and the remaining time until the refilling of grease is needed, or the date and time when the refilling of grease is needed can be predicted exactly. Moreover, since the residual quantity of grease and the remaining time or the date and time when the refilling of grease is needed are displayed on the display, the running out of grease can be prevented by refilling the reserve tank with grease at a proper time.

[0090] Further, even when only a particular portion of injection molding machine such as the injection mechanism or the mold clamping mechanism is operated, the occurrence of running out of grease in the particular portion can be prevented.

Claims

1. An automatic lubricator for an injection molding machine, comprising:

    a lubricating pump for supplying lubricant to movable parts of the injection molding machine; and
    a controller for controlling an interval of operation of said lubricating pump or operating time of said lubricating pump for one lubrication based on at least one of cycle time of the injection molding machine, temperature of the lubricated parts and ambient temperature.

2. An automatic lubricator for an injection molding machine according to claim 1, wherein said controller controls the interval of operation of said lubricating pump based on the cycle time of the injection molding machine and the temperature of the lubricated parts.

3. An automatic lubricator for an injection molding machine according to claim 1, wherein said controller controls the operating time of said lubricating pump for one lubrication based on the ambient temperature of the injection molding machine.

4. An automatic lubricator for an injection molding machine according to claim 1, wherein said controller makes said lubricating pump perform the lubricating operation each time when set number of shots are completed and also adaptively controls said lubrication interval by adjusting the set number of shots.

5. An automatic lubricator for an injection molding machine according to claim 4, wherein said controller makes said lubricating pump perform the lubricating operation each time when at least one of the number of injection operations and the number of mold clamping operations of the injection molding machine reaches said set number of shots.

6. An automatic lubricator for an injection molding machine according to any one of claims 1 to 5, wherein said automatic lubricator further comprises a display device, and said controller makes said display device display at least one of the residual quantity of lubricant in a reserve tank, remaining time until refilling of lubricant is needed, and date and time when the refilling of lubricant is needed.

F I G. 1

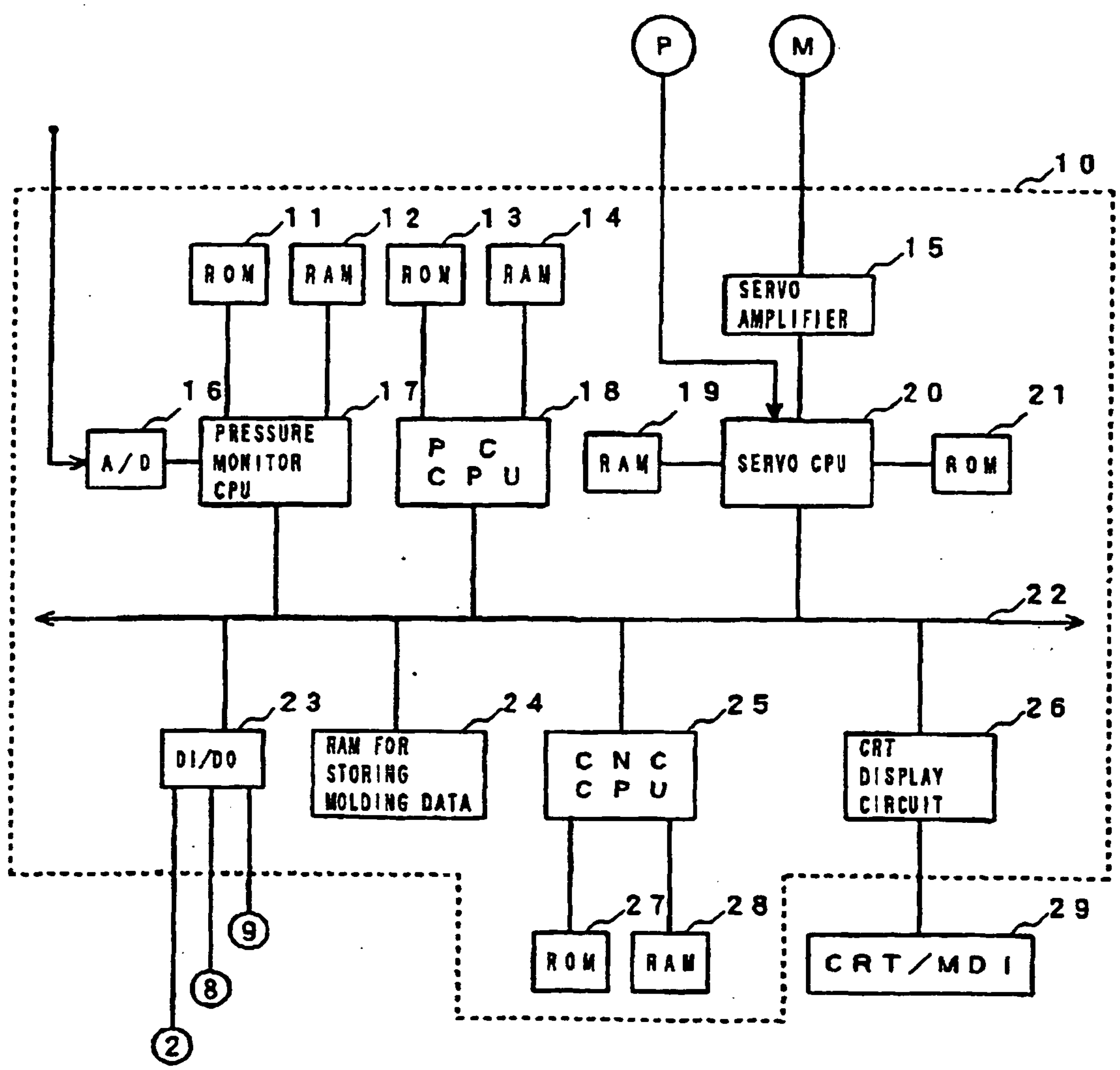

P
M
10
11
12
13
14
15
ROM
RAM
ROM
RAM
SERVO AMPLIFIER
16
17
18
19
20
21
A/D
PRESSURE MONITOR CPU
P C C P U
RAM
SERVO CPU
ROM
22
23
24
25
26
DI/DO
RAM FOR STORING MOLDING DATA
C N C C P U
CRT DISPLAY CIRCUIT
27
28
29
ROM
RAM
CRT/MDI
9
8
2

FIG.2

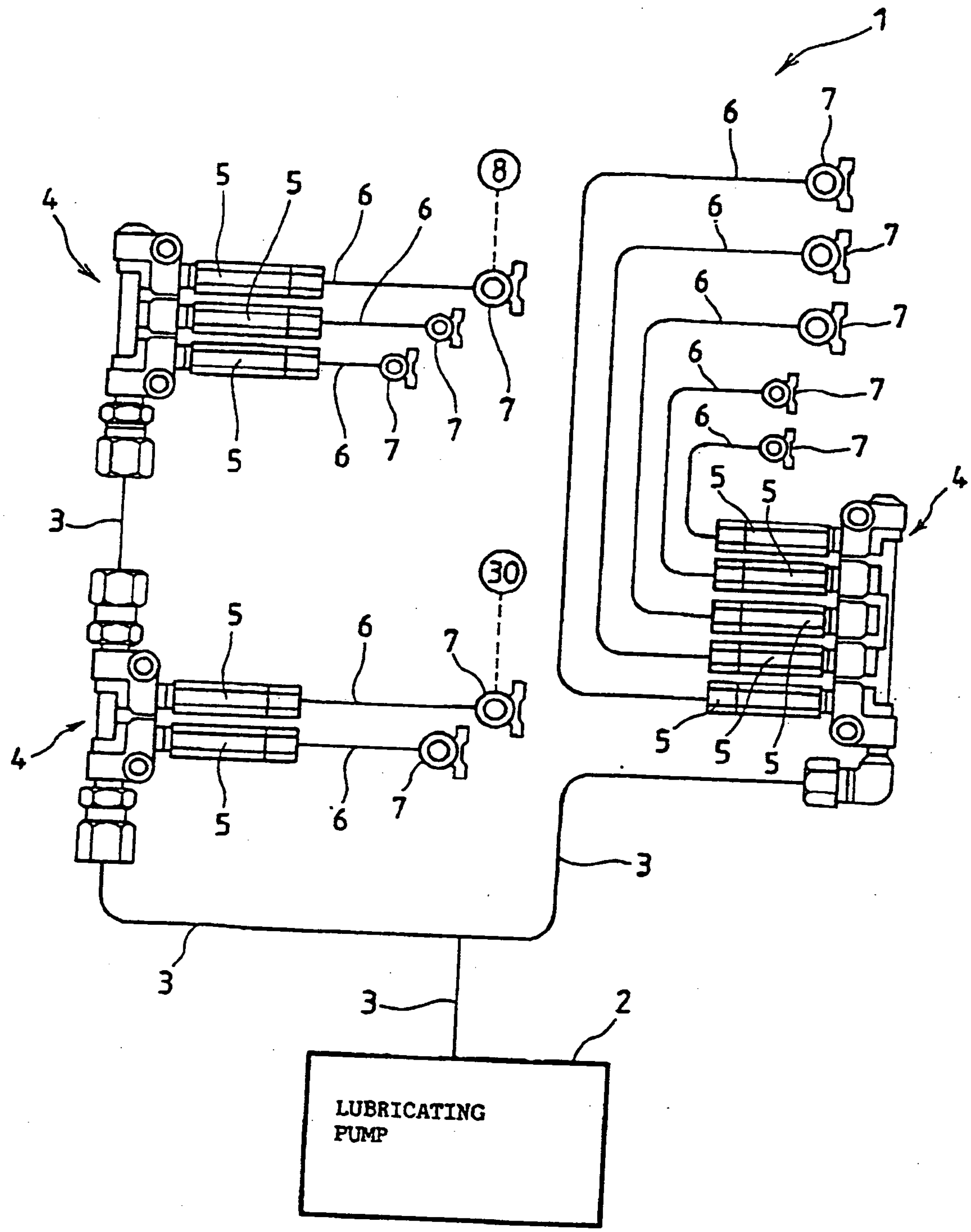


FIG. 3

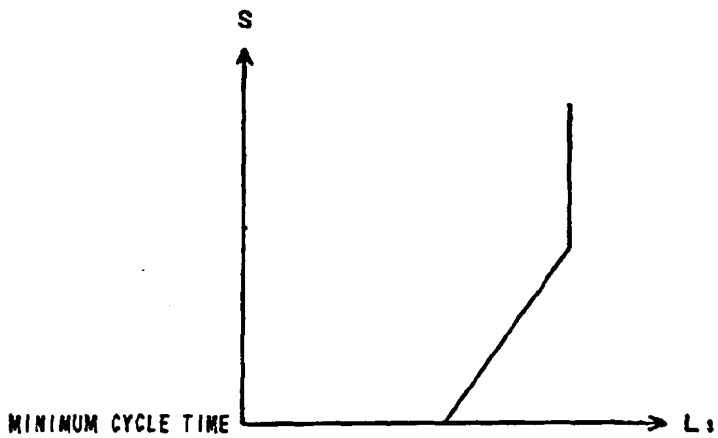


FIG. 4

t1	40~30	30~20	20~10	10~
ΔL	ΔL1	ΔL2	ΔL3	ΔL4

FIG. 5

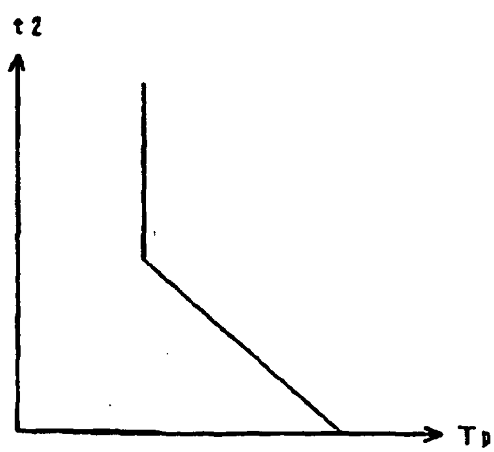
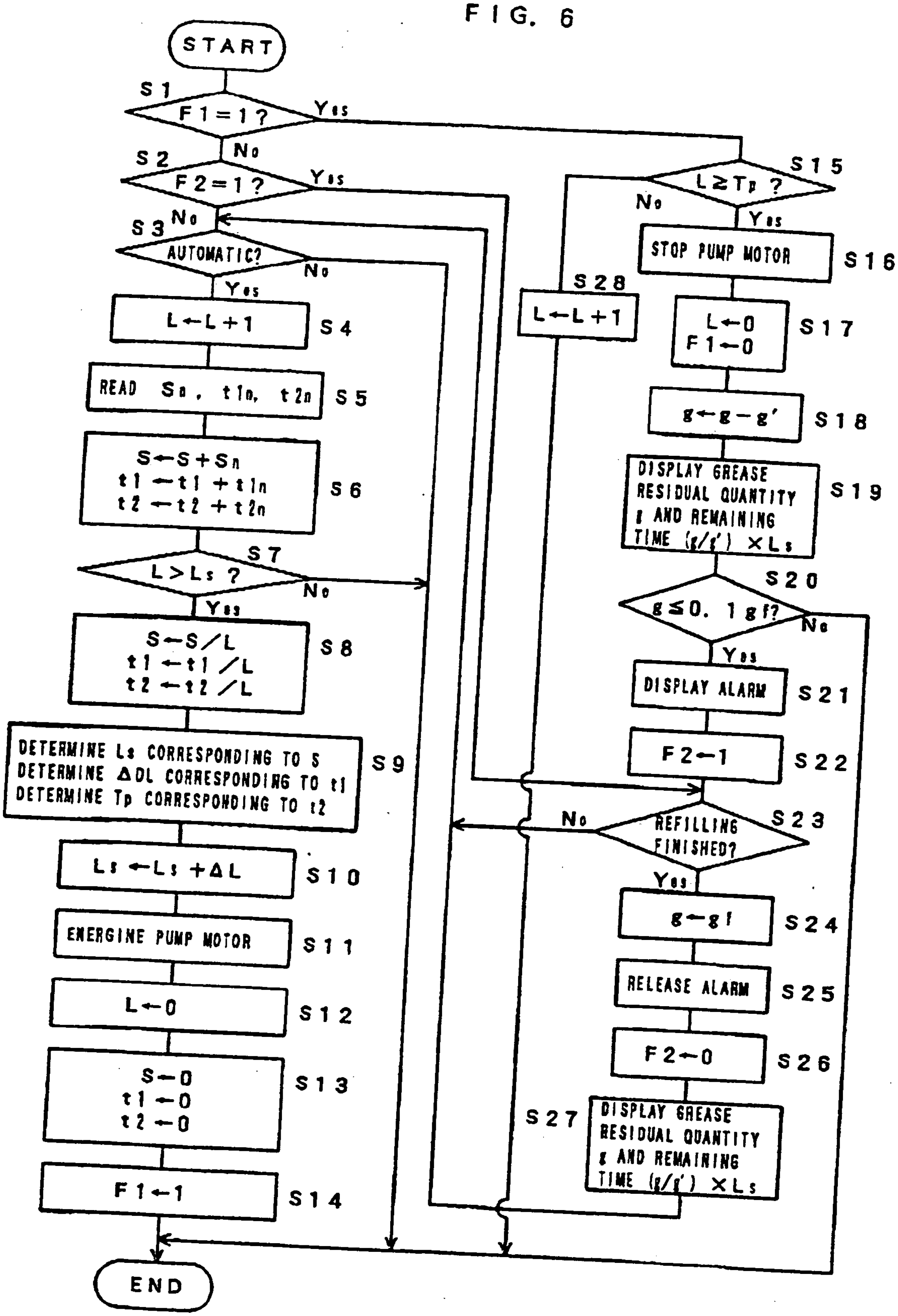


FIG. 6


START
S1
F1=1?
Yes
No
S2
F2=1?
S3
AUTOMATIC?
L←L+1
S4
READ Sn, t1n, t2n
S5
S←S+Sn
t1←t1+t1n
t2←t2+t2n
S6
S7
L>Ls ?
S←S/L
t1←t1/L
t2←t2/L
S8
DETERMINE Ls CORRESPONDING TO S
DETERMINE ΔDL CORRESPONDING TO t1
DETERMINE Tp CORRESPONDING TO t2
S9
Ls←Ls+ΔL
S10
ENERGINE PUMP MOTOR
S11
L←0
S12
S←0
t1←0
t2←0
S13
F1←1
S14
END
S15
L≥Tp ?
STOP PUMP MOTOR
S16
S28
L←L+1
L←0
F1←0
S17
g←g−g'
S18
DISPLAY GREASE
RESIDUAL QUANTITY
g AND REMAINING
TIME (g/g') ×Ls
S19
S20
g≤0. 1gf?
DISPLAY ALARM
S21
F2←1
S22
REFILLING
FINISHED?
S23
g←gf
S24
RELEASE ALARM
S25
F2←0
S26
S27
DISPLAY GREASE
RESIDUAL QUANTITY
g AND REMAINING
TIME (g/g') ×Ls

F I G. 7

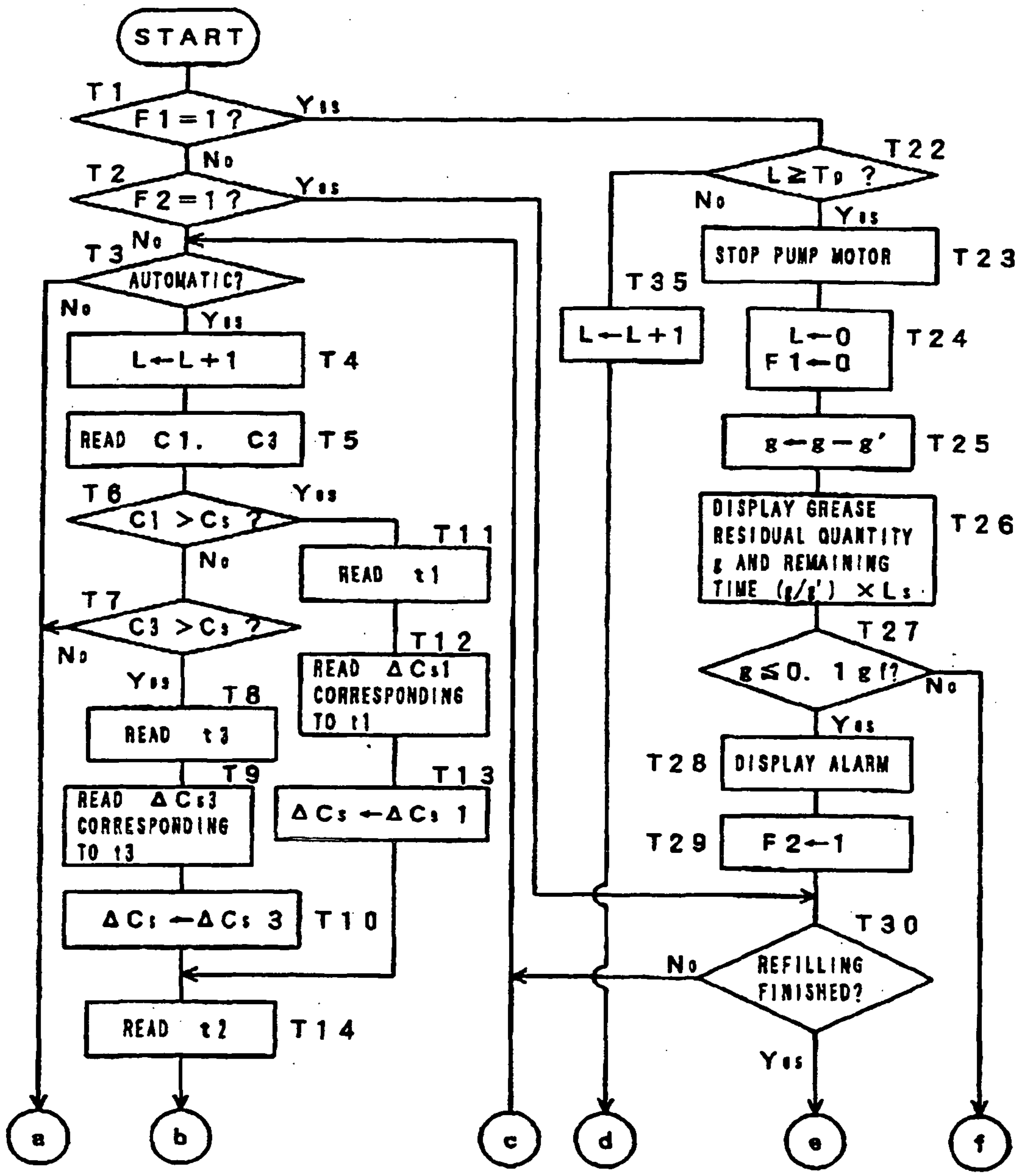
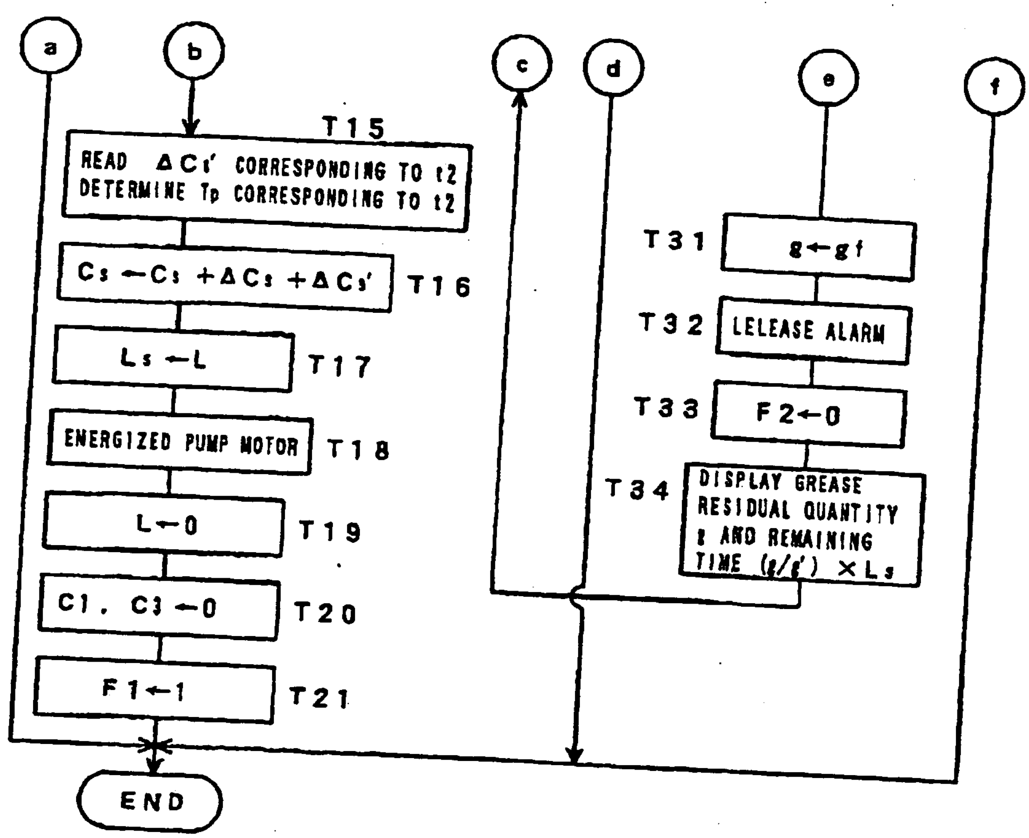

START
T1
F1=1?
Yes
No
T2
F2=1?
T3
AUTOMATIC?
L←L+1
T4
READ C1, C3
T5
T6
C1 >Cs ?
T7
C3 >Cs ?
READ t3
T8
READ ΔCs3 CORRESPONDING TO t3
T9
ΔCs ←ΔCs 3
T10
READ t1
T11
READ ΔCs1 CORRESPONDING TO t1
T12
ΔCs ←ΔCs 1
T13
READ t2
T14
T22
L≧Tp ?
STOP PUMP MOTOR
T23
T35
L←L+1
L←0
F1←0
T24
g←g−g'
T25
DISPLAY GREASE RESIDUAL QUANTITY g AND REMAINING TIME (g/g') ×Ls
T26
T27
g≦0. 1gf?
DISPLAY ALARM
T28
F2←1
T29
T30
REFILLING FINISHED?
a
b
c
d
e
f

FIG. 8


a
b
c
d
e
f
T15
READ ΔCs' CORRESPONDING TO t2
DETERMINE Tp CORRESPONDING TO t2
Cs ←Cs +ΔCs +ΔCs'
T16
Ls ←L
T17
ENERGIZED PUMP MOTOR
T18
L←0
T19
C1, C3 ←0
T20
F1←1
T21
END
T31
g←gf
T32
LELEASE ALARM
T33
F2←0
T34
DISPLAY GREASE RESIDUAL QUANTITY g AND REMAINING TIME (g/g') ×Ls

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 30 0471

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP 0 439 626 A (FANUC LTD) 7 August 1991 * the whole document *	1	F16N29/04 F16N11/08
A	PATENT ABSTRACTS OF JAPAN vol. 096, no. 012, 26 December 1996 & JP 08 207108 A (JAPAN STEEL WORKS LTD:THE), 13 August 1996 * abstract *	1	
A	US 5 297 953 A (WANG PO-LI) 29 March 1994 * column 4, line 1 - column 5, line 4; figures *	1	
A	US 5 182 720 A (BECK DAVID C ET AL) 26 January 1993 * column 2, line 29 - column 6, line 59; figures *	1	
A	EP 0 303 938 A (TAKANO CORP) 22 February 1989 * column 5, line 11 - column 7, line 54; figures *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	EP 0 612 891 A (KOMATSU MFG CO LTD) 31 August 1994 * column 10, line 20 - column 20, line 18; figures *	1	F16N B29C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22 April 1999	Mouton, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 99 30 0471

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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22-04-1999

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EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

United States Patent Office 3,508,300
Patented Apr. 28, 1970

1

3,508,300
ENCLOSED ADJUSTABLE CLAMPING MECHANISM WITH LUBRICATING SYSTEM

Harrie Martin Allard and Henry Randall Parker, Nashua, N.H., assignors to Improved Machinery Inc., Nashua, N.H., a corporation of Delaware

Filed June 12, 1967, Ser. No. 645,347
Int. Cl. B29f 1/00, 1/06
U.S. Cl. 18—30 11 Claims

ABSTRACT OF THE DISCLOSURE

An injection molding machine including a clamping means or mechanism which comprises a toggle linkage and cylinder means for actuating the toggle linkage, such cylinder means being supported below the toggle linkage by supporting arms. The clamping means is immersed in lubricant to locate the connections of the supporting arms to the cylinder means in the lubricant; and lubricant is supplied onto the connections of the toggle linkage and onto the connections between the supporting arms and the platens. Also, the tie rods are longitudinally movable for providing adjustment of the space between the mold carrying platens; and a mold carrying platen is selectively driven relative to the injection unit by a cylinder-and-piston drive mechanism.

This invention relates to improved clamp drive mechanisms in injection molding machines.

Injection molding machines usable with molds of various thicknesses must be adjusted to accommodate each new set of molds. It is not desirable to adjust the stroke of the clamping mechanism for proper mating of each new set of molds as this mechanism is meticulously designed to impose massive forces, in the order of tens of tons, and such adjusting capabilities would increase the complexity of the mechanism. In some machines adjustment is made by moving the platen accommodating the injection unit on tie rods which connect the clamping mechanism to that platen. This places the adjusting mechanism in the already-congested area of the injection unit, where access and operation are quite difficult.

Clamping mechanisms of these machines generally employ a toggle linkage with its two outer ends connected to a fixed and a movable platen, and its center pin to a connecting rod connected to a piston in a hydraulic cylinder. The arrangement usually is such that increasing the pressure on the rod side of the piston brings the outer ends of the toggle links toward each other and opens the mold, while pressure on the other side of the piston drives the outer ends apart and closes the mold. The toggle linkage is a large but very precisely constructed mechanism and it is essential that it be kept clean and well lubricated. Portions of the linkage that protrude above the machine increase its height and are exposed to dust and corrosive elements in the atmosphere that increase wear and hasten deterioration of the linkage. The exposed joints are difficult to keep properly lubricated as well.

It is therefore a primary object of this invention to provide an injection molding machine having a toggle linkage which may be totally enclosed within the body of the machine permitting a reduction in the height of the machine and allowing total lubrication of the linkage while protecting it from dust and corrosion.

It is a further object of this invention to provide an adjustment mechanism in an injection molding machine which can quickly, easily, and uniformly adjust for each set of molds used, whose setting, once adjusted, is resistant to change by extraneous forces, and which is accessibly placed on the injection molding machine.

The invention features an injection molding machine which may include a compartment for enclosing the clamping mechanism, the clamping mechanism including a toggle linkage and a hydraulic clamping cylinder, the toggle linkage having a first link connected at its outer end to a clamping platen and a second link connected at its outer end to a moving platen, the links being pivotally interconnected at their inner ends, the clamping platen being fixed to the base of the machine and the moving platen being slidable on a guide member between the clamping platen and a second platen which is spaced from the clamping platen; the hydraulic clamping cylinder is supported from the clamping and moving platens by first and second arms, respectively, pivotally connected to the cylinder, and a lubricating system disposed within the compartment for lubricating the clamping mechanism.

In preferred embodiments, the machine may include an adjustment mechanism on the clamping platen and the guide member includes a plurality of tie rods, the second platen being attached to, and movable as a unit with, the tie rods. The adjustment mechanism may include a drive nut threadably engaged with each of the tie rods, a drive wheel connected with one of the drive nuts for rotating that drive nut and moving the associated tie rod through it, and a drive chain engaging all of the drive nuts for rotating them in unison to insure alignment of the second platen. Other embodiments may include drive means which are connected to the second platen for moving that platen and adjusting the mold setting in cooperation with the adjustment mechanism and which may be connected to the injection unit of the machine for moving the second platen and injection unit relative to each other.

Other objects, features, and advantages will appear from the following description of a preferred embodiment of the invention, taken together with the attached drawings, in which:

FIG. 1 is an elevation of an injection molding machine according to this invention;

FIG. 2 is a plan view of the machine of FIG. 1;

FIG. 3 is a perspective view of the end of the machine at the left of FIGS. 1 and 2.

There is shown in the drawings an injection molding machine having a base **10** which supports runners **12**, having guide edges **14**, and injection unit **16**. Clamping platen **18** is fixed to one end of said runners and contains four bores **20** through which pass four tie rods **22**. Tie rods **22** are attached to adjustable platen **24** and position it relative to clamping platen **18**. They further act as guides for moving platen **26** in bores **28** and mold plate **30** in bores **32**. Brass shoes **34**, mounted on the bottoms of platens **24** and **26**, and plate **30** prevent excessive wear of runners **12** as these members slide on them.

Tie rods **22** are moved through bores **20** in clamping platen **18** in order to position adjustable platen **24** in accordance with the thickness of particular molds. Threaded ends **36** of tie rods **22** are engaged by an adjustment mechanism which includes sprockets **38** and **42**, drive nuts **40**, hand wheel **44**, and chain **46**, and which is movable with tie rods **22** independent of platen **18**. Three sprockets **38** rotatably supported by tie rods **22** are keyed to rotate with drive nuts **40** and a fourth sprocket **42** also rotatably supported by a tie rod is keyed to rotate with hand wheel **44**. Rotation of hand wheel **44** rotates its associated sprocket and through chain **46** rotates sprockets **38** and drive nuts **40**.

Tie rod clamps **52** mounted on threaded clamp studs **54** secured in clamping platen **18** are held firmly against bearing surfaces **56** on the ends of tie rods **22** by jam nuts **58**, to prevent the tie rods from being moved relative to clamping platen **18** by forces exerted during operation of the machine.

2

April 28, 1970 H. M. ALLARD ET AL 3,508,300

ENCLOSED ADJUSTABLE CLAMPING MECHANISM WITH LUBRICATING SYSTEM

Filed June 12, 1967

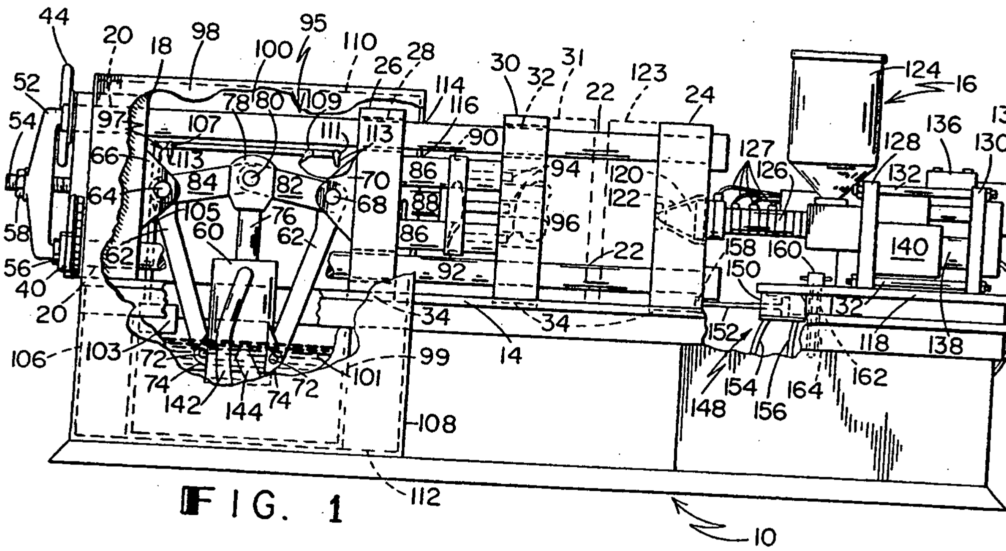

FIG. 1

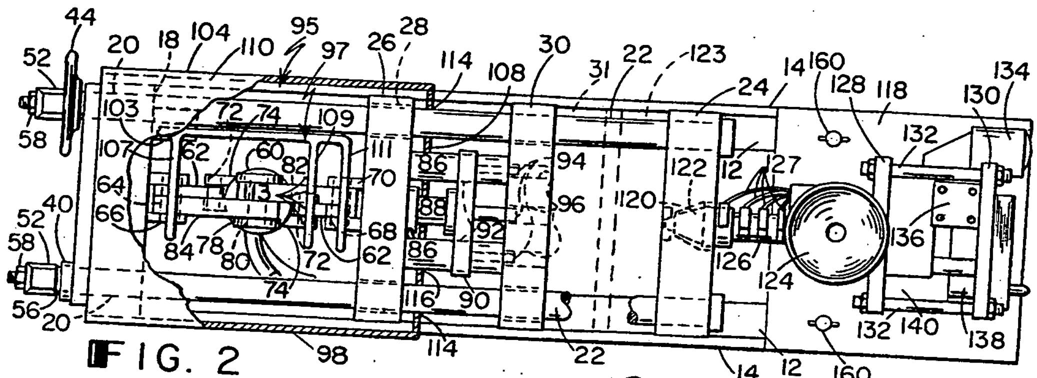

FIG. 2

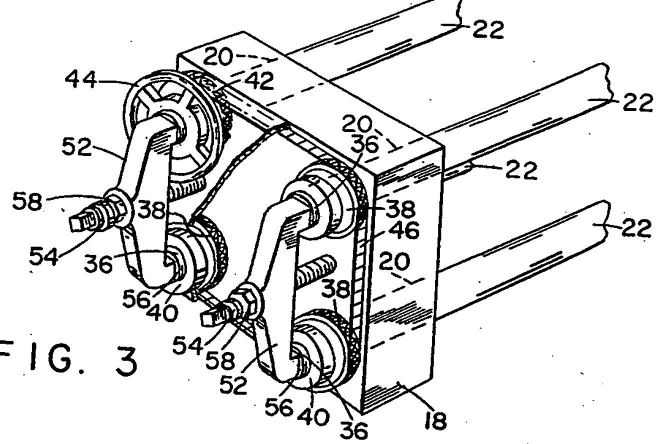

FIG. 3

The clamping mechanism or means of the machine includes a toggle linkage and cylinder means comprising a hydraulic cylinder **60** suspended by arms **62** from pivot pin **64** in mounting **66** on clamping platen **18** and pivot pin **68** in mounting **70** on moving plate **26**. Arms **62** are pivotally connected to cylinder **60** by pins **72** in mountings **74**. The force developed on the piston within cylinder **60** is communicated to the system by a connecting rod **76** and bearing **78** containing a wrist pin **80**. The toggle linkage employs link **82** connected to pins **68** and **80** and link **84** connected to pins **64** and **80**.

Mold plate **30** is fastened to moving platen **26** by four spacer rods **86**. Hydraulic knockout cylinder **88**, attached to moving platen **26**, drives ejector plate **90** supported and guided by its circular recesses **92** on spaced rods **86**. There are seventeen ejector points **94** (only a few are shown) carried by ejector plate **90**. They are received in bores **96** in mold plate **30** and corresponding bores in mold half **31**.

Side panels **98** and **100**, end panels **106** and **108**, cover panel **110** and base panel **112** form a compartment **95** which permits continuous lubrication of the clamp mechanism by the lubrication system **97** and protects it from atmospheric dust and corrosion. Tie rods **22** pass through apertures **114**, and spacer rods **86** through apertures **116**, in plate **108**. At the bottom of compartment **95** is a lubricant reservoir **99** containing the lubricant **101**. Lubricating system **97** draws the lubricant from reservoir **99** by means of pump **103** and delivers it through pipe **105** to conduits **107**, **109**, and **111** associated with pivot pins **64**, **80** and **68**, respectively. From conduits **107**, **109**, and **111** the lubricant is directed by a plurality of dispensers **113** toward the associated pins **64**, **80** and **68**.

Injection unit **16** is mounted on carriage **118**, slidable on runners **12**, to permit alignment of injector nozzle **120** in conical port **122** in adjustable platen **24**. Nozzle **120** enters the mold directly through a corresponding port in mold half **123**.

Dry molding material placed in hopper **124** moves into wear resistant steel barrel **126** through a feed hole. The material is heated by electric heating bands **127** which, in conjunction with the pressure applied by the usual rotating screw, not shown, within barrel **126**, plasticizes the molding material. The barrel **126** and hopper **124** assembly is supported on feeder crosshead **128** mounted on carriage **118** and is connected to ram crosshead **130** by guide bars **132**. The screw is driven by hydraulic motor **134** through gears in gear housing **136**. The screw is rammed forward, injecting the plasticized material into the mold, by injector rams **138** slidable in injector cylinders **140**. Hydraulic power is applied to the ram **138** and cylinder **140**, as it is to the clamping cylinder **60**, and knockout cylinder **88**, by the main hydraulic system of the machine contained within base **10** below injector unit **16**. Cylinder **60** is caused to close the mold by an increase in hydraulic pressure on line **142**, and to open it by an increase in hydraulic pressure on line **144**.

Adjustment of the mold half spacing is accomplished by rotating hand wheel **44** until the nuts **40** are displaced from platen **18** by a distance equal to the desired increase in distance at the mold area. Then cylinder **60** is pressurized to move palten **26** toward platen **24** so that mold half **31** contacts mold half **123** driving platen **24** away from platen **18** until nuts **40** once again bear on platen **18**. Final adjustment may be accomplished with precision by rotating hand wheel **44** to draw platen **24** toward platen **18** for exact spacing of the mold halves. Jam nuts **58** must now be drawn up on studs **54** to secure clamps **52**. Reducing the space at the mold area is accomplished by backing off jam nuts **58** a distance equal to the reduction desired and then rotating hand wheel **44** to move platen **24** and draw tie rods **22** through platen **18** until bearing surfaces **56** are again contacting clamps **52**.

Increasing the pressure in line **142** drives rod **76** into cylinder **60**, drawing wrist pin **80** and the associated ends of links **82** and **84** downwardly. This tends to drive pins **64** and **68** apart, resulting in moving platen **26** being driven away from fixed clamping platen **18**, and closing the mold. Links **82** and **84** are nearly colinear in the closed mold condition; less than complete horizontal alignment is desirable to increase the speed of operation and avoid locking. The molds are parted by an increase in the pressure in line **144**. This drives rod **76** out of cylinder **60**, moving pin **68** toward pin **64**, which draws moving platen **26** toward clamping platen **18**, opening the mold.

Carriage **118** may be moved relative to adjustable platen **24** for proper engagement of nozzle **120** and port **122** by drive mechanism **148** including cylinder **150** and piston **152**, FIG. 1. Cylinder **150** mounted on carriage **118** drives piston **152** by means of hydraulic power supplied through lines **154** and **156**; piston **152** is mounted to platent **24** in block **158**. Drive mechanism **148** may be caused to supply the force to move adjustable platen **24** relative to carriage **118** and clamping platen **18** for adjusting the mold space between mold halves **31** and **123** by inserting clevis pins **160** in bores **162** in carriage **118** and coperating bores **164** in base **10**. With pins **160** so engaged carriage **118** cannot respond to the urgings of drive mechanism **148**. Instead, the force applied by drive mechanism **148** moves platen **24**.

Thus, drive means **148** may be employed to give a power assist to the manual adjustment mechanism controlled by hand wheel **44**. To increase the distance between platens **24** and **26**, hand wheel **44** is rotated until the distance between drive nuts **40** and platen **18** is equal to the increased distance desired at the mold area. Pressurizing cylinder **150** through line **154** drives piston **152** and platen **24** away from moving platen **26** until nuts **40** once again bear on platen **18**. Clamps **52** are now brought against bearing surfaces **56** by moving jam nuts **58** toward platen **18** a distance equal to the increased distance between platens **24** and **26**.

Decreasing the distance between platens **24** and **26** is accomplished by moving jam nuts **58** away from clamps **52** a distance equal to the desired decrease between platens **24** and **26** and pressurizing cylinder **150** through line **156**. This action drives piston **152** and platen **24** towards moving platen **26** until bearing surfaces **56** of tie rods **22** once again engage clamps **52**; hand wheel **44** is now rotated until drive nuts **40** again bear on platen **18**.

Removing clevis pins **160** when jam nuts **52** and drive nuts **40** are drawn up tight permits drive mechanism **148** to be used to move carriage **118** toward and away from platen **24** for proper positioning of nozzle **120** in port **122**.

Other embodiments will occur to those skilled in the art and are within the following claims.

What is claimed is:

1. An injection molding machine comprising a clamping platen, a second platen spaced from said clamping platen, a moving platen positioned and movable between said clamping and second platens, clamping means including a toggle linkage actuatable for moving said moving platen and cylinder means for actuating said toggle linkage, said toggle linkage including first and second links having inner ends and outer ends, said first link being connected at its outer end to said clamping platen and said second link being connected at its outer end to said moving platen, said links being pivotally interconnected at their inner ends, a first supporting arm connected at opposite ends to said clamping platen and said cylinder means, a second supporting arm connected at opposite ends to said moving platen and said cylinder means, said supporting arms supporting said cylinder means from said clamping platen and said moving platen, and means defining a compartment enclosing said clamping means, said compartment containing lubricant at a level to cause said clamping means to be sufficiently im-

mersed in the lubricant to locate connections of said clamping means in the lubricant.

2. An injection molding machine according to claim 1, wherein said clamping means is only partially immersed in the lubricant whereby other connections of said clamping means are out of such lubricant, and means are provided for directing lubricant on said other connections of said clamping means.

3. An injection molding machine according to claim 2, wherein said lubricant directing means includes dispensing means for directing lubricant onto said connections of said links and onto the connections of said supporting arms to said platens.

4. An injection molding machine comprising a clamping platen, a second platen spaced from said clamping platen, a moving platen positioned and movable between said clamping and second platens, clamping means including a toggle linkage actuatable for moving said moving platen and cylinder means for actuating said toggle linkage, said toggle linkage including first and second links having inner ends and outer ends, said first link being connected at its outer end to said clamping platen and said second link being connected at its outer end to said moving platen, said links being pivotally interconnected at their inner ends, a first supporting arm connected at opposite ends to said clamping platen and said cylinder means, a second supporting arm connected at opposite ends to said moving platen and said cylinder means, said supporting arms supporting said cylinder means below said interconnection of said links, means defining a compartment enclosing said clamping means, said compartment containing lubricant at a level to cause the connections of said supporting arms to said cylinder means to be immersed in the lubricant and said connections of said links to be above the level of such lubricant, and means for supplying lubricant to said connections of said links.

5. An injection molding machine according to claim 4, wherein said lubricant supplying means comprises a lubricant conveying conduit associated with each of said connections of said links, each of said conduits being provided with a plurality of dispensers for directing the lubricant onto its associated connection.

6. An injection molding machine according to claim 5, wherein the connections of said supporting arms to said platens are arranged such that said dispensing means directs lubricant thereon.

7. An injection molding machine according to claim 4, further comprising a plurality of tie rods connected to said second platen for movement therewith, said tie rods extending through openings in said moving and clamping platens and having ends on the opposite side of said clamping platen from said second platen, and adjustment means including a drive nut threadedly connected to each of said tie rod ends, a drive wheel associated with one of said drive nuts for rotatably driving the latter, a drive chain connecting all of said drive nuts whereby rotation of said one drive nut provides simultaneous rotation of all thereof, a clamp stud mounted on said clamping platen, a clamp mounted on said clamp stud and bearing on the tie rod ends, and a jam nut on said clamp stud and securing said clamp against said tie rod ends to prevent longitudinal movement of said tie rods.

8. An injection molding machine according to claim 7, wherein there are a plurality of said clamp studs, clamps and jam nuts, each clamp, clamp stud and jam nut being associated with a pair of tie rods and each of said clamps having two bearing surfaces, one for each tie rod associated therewith.

9. An injection molding machine comprising a clamping platen, a second platen spaced from said clamping platen, a moving platen positioned and movable between said clamping and second platens, a plurality of tie rods connected to said second platen for movement therewith, said tie rods extending through openings in said moving and clamping platens and having ends on the opposite side of said clamping platen from said second platen, and adjustment means including a drive nut threadedly connected to each of said tie rod ends, a drive wheel associated with one of said drive nuts for rotatably driving such one drive nut, a drive chain connecting all of said drive nuts whereby rotation of said one drive nut provides simultaneous rotation of all thereof, a clamp stud connected to said clamping platen, a clamp mounted on said clamp stud and bearing on the tie rod ends, and a jam nut on said clamp stud and securing said clamp against said tie rod ends to prevent longitudinal movement of said tie rods.

10. An injection molding machine according to claim 9, wherein there are a plurality of said clamp studs, clamps and jam nuts, each clamp, clamp stud and jam nut being associated with a pair of tie rods and each of said clamps having two bearing surfaces, one for each tie rod associated therewith.

11. An injection molding machine according to claim 9, further comprising an injection unit, means for preventing movement of said injection unit relative to said second platen, and drive means for moving said second platen relative to said injection unit.

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M. O. SUTTON, Assistant Examiner

U.S. Cl. X.R.

29—260, 261; 254—29.5

US005297953A

United States Patent [19]

Wang

[11] Patent Number: 5,297,953

[45] Date of Patent: Mar. 29, 1994

[54] TOGGLED INJECTION MOLDING MACHINE HAVING A LUBRICATING SYSTEM

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[73] Assignee: Fu Chun Shin Machinery Manufacture Co., Ltd., Bay-Tow Village, Taiwan

[21] Appl. No.: 994,999

[22] Filed: Dec. 22, 1992

[51] Int. Cl.[5] B29C 45/66

[52] U.S. Cl. 425/593; 425/451.6

[58] Field of Search 425/589, 592, 593, 450.1, 425/451.5, 451.6

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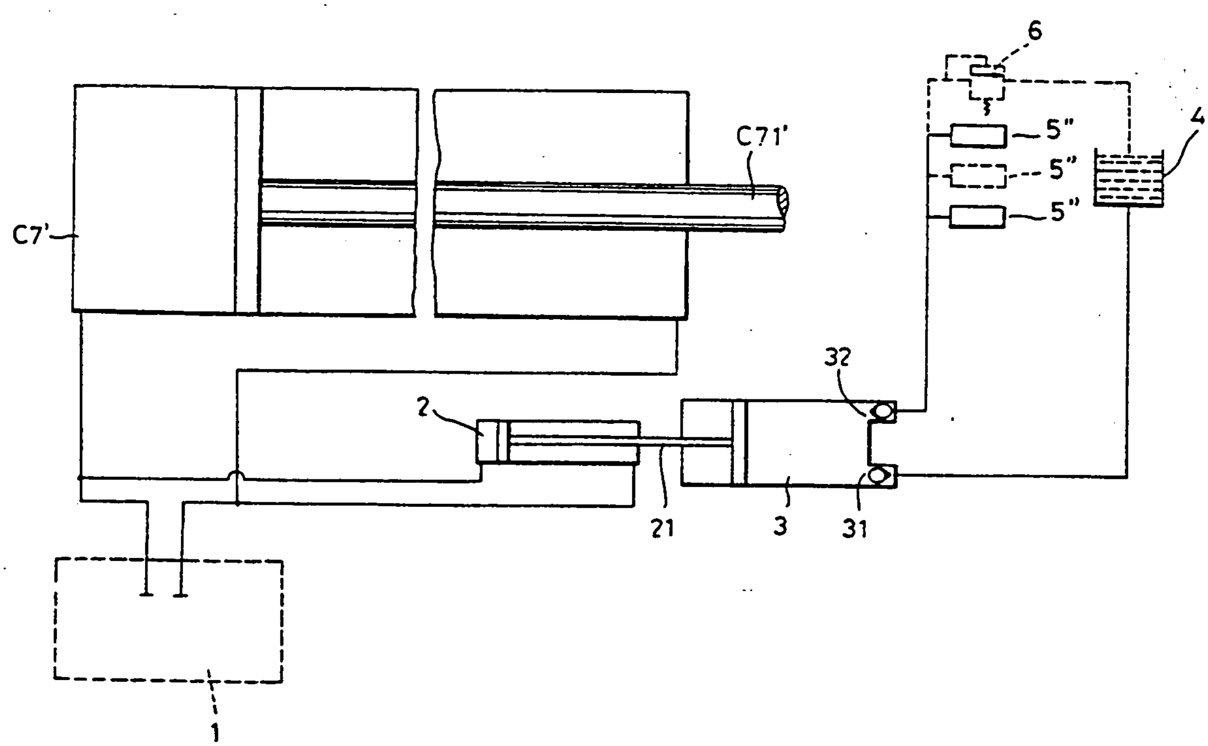
Primary Examiner—Tim Heitbrink

[57] ABSTRACT

A lubricating system is installed in a common injection molding machine which includes a stationary mold half unit, a movable mold half unit which can be moved towards and away from the stationary mold half unit, a toggle mechanism coupled with the movable mold half unit so as to be driven to move the movable mold half unit, a mold pressing hydraulic cylinder having a piston rod coupled with the toggle mechanism so as to drive the toggle mechanism, and an oil feed system coupled with the mold pressing hydraulic cylinder so as to provide hydraulic pressure for the mold pressing hydraulic cylinder to drive the toggle mechanism. The lubricating system includes a pump driving hydraulic cylinder coupled with the oil feed system so that the pump driving hydraulic cylinder can be operated synchronously with the mold pressing hydraulic cylinder, an oil tank for storing lubricating oil, and a lubricating oil pump coupled with the oil tank, the toggle mechanism and the piston rod of the pump driving hydraulic cylinder so that the oil pump is activated by the piston rod of the pump driving hydraulic cylinder so as to receive lubricating oil from the oil tank and then force the lubricating oil from the oil pump to the toggle mechanism in order to lubricate the latter.

2 Claims, 4 Drawing Sheets



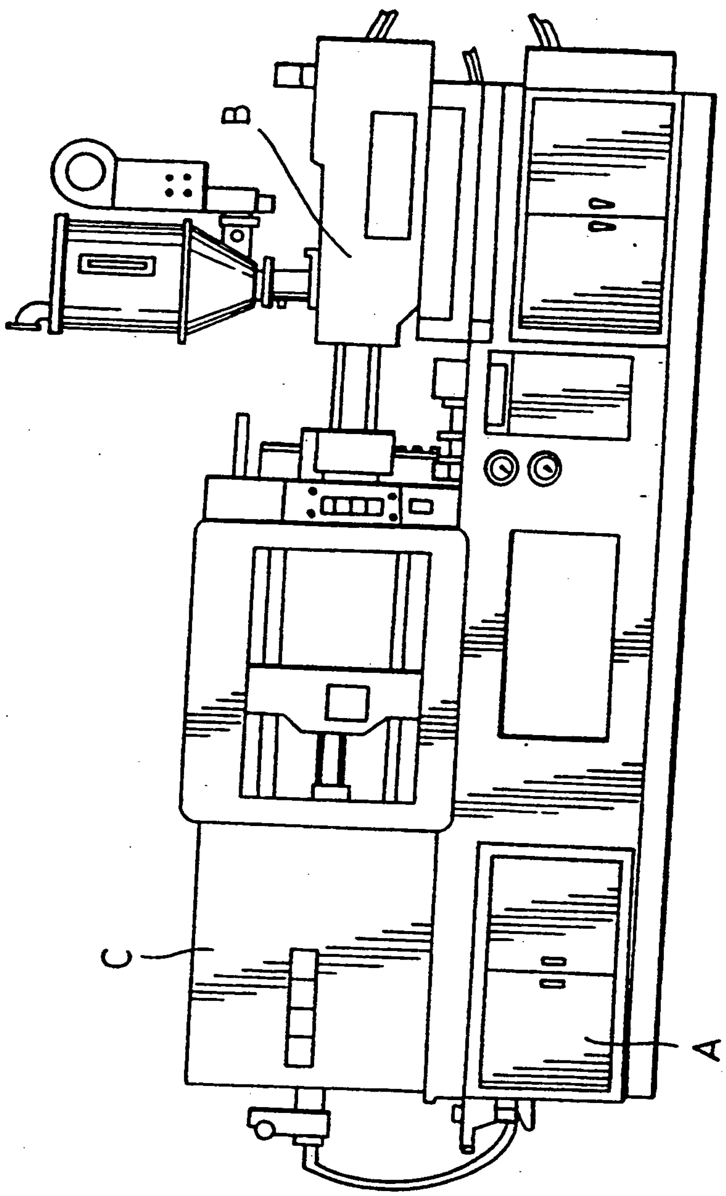


FIG. 1
(PRIOR ART)

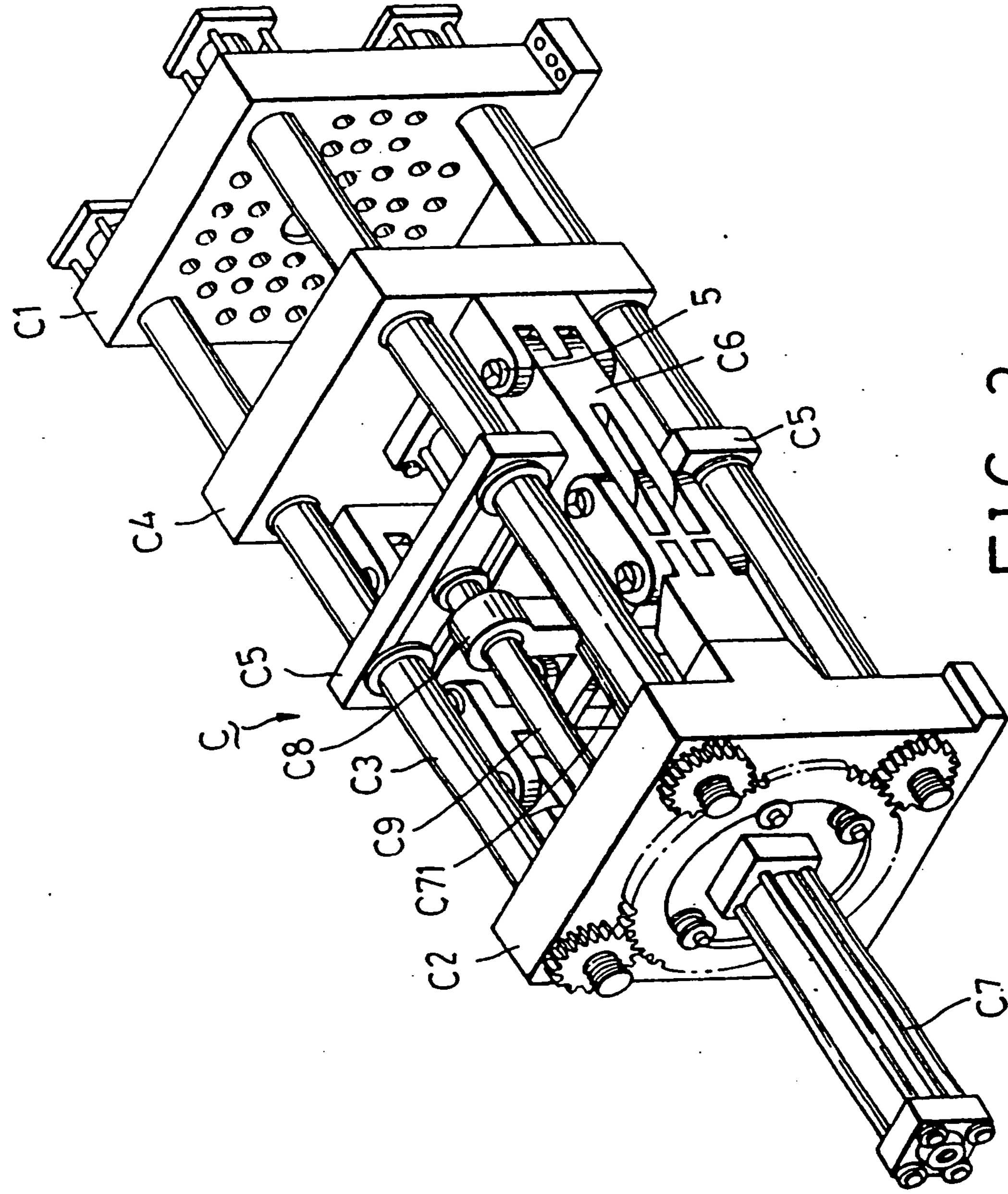


FIG. 2
(PRIOR ART)

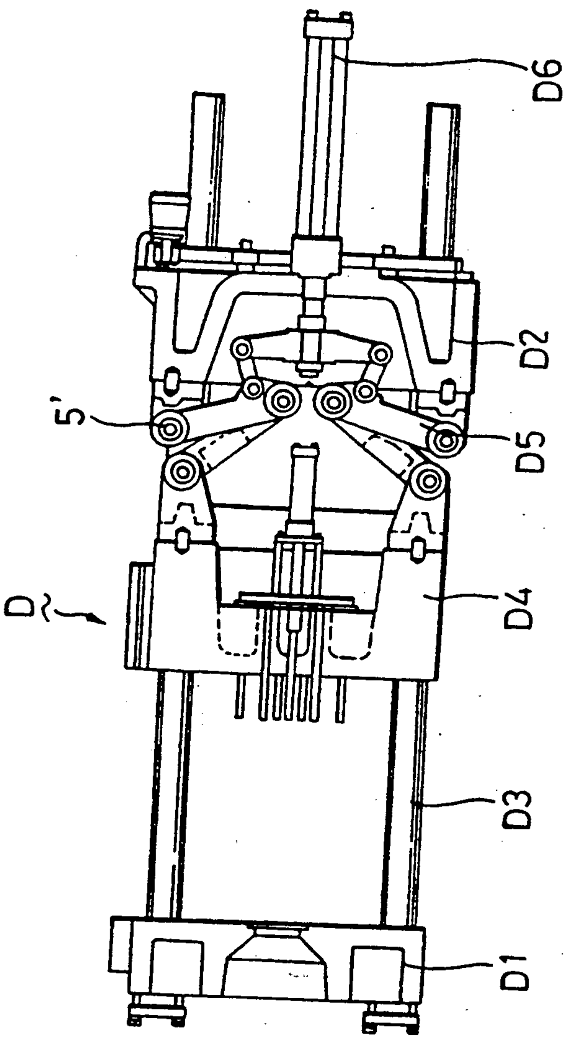


FIG. 3
(PRIOR ART)

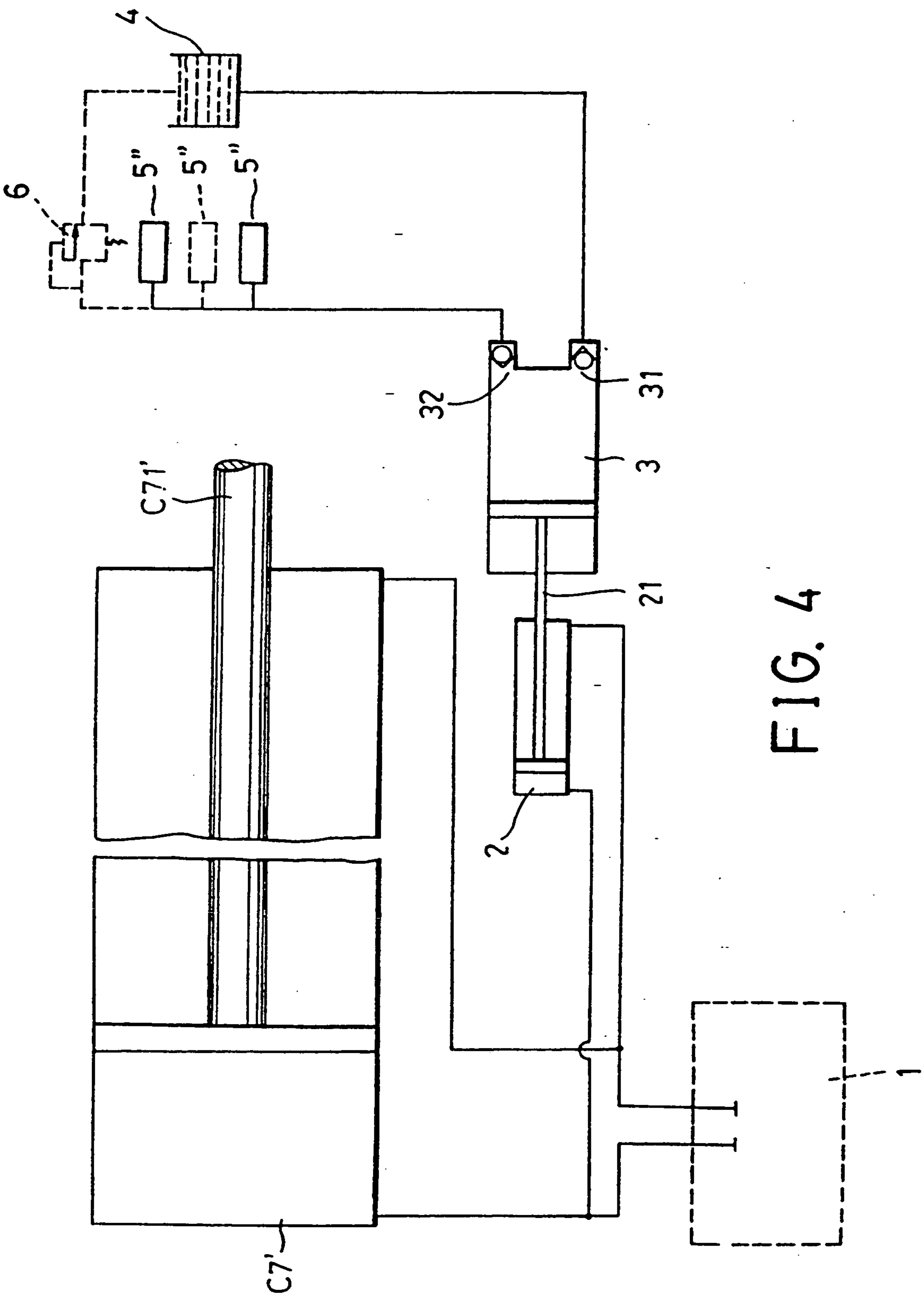


FIG. 4

TOGGLED INJECTION MOLDING MACHINE HAVING A LUBRICATING SYSTEM

BACKGROUND OF THE INVENTION

1. Field Of The invention

This invention relates to a lubricating system for an injection molding machine, more particularly to a lubricating system which is efficient and relatively inexpensive.

2. Description Of The Related Art Referring to FIG. 1, a common injection molding machine includes an elongated main body (A) which is adapted to be provided with a motor (not shown), an oil tank (not shown), an oil system (not shown), and a control circuit system (not shown), etc. therein. A material feeding system (B) is mounted on one end portion of the main body (A), and a mold pressing system (C) is mounted on the other end portion of the main body (A) and accepts material from the material feeding system (B) for molding. Referring to FIG. 2, the mold pressing system (C) includes a stationary mold half unit (C1), a stationary wall (C2), four horizontal longer connecting rods (C3), a movable mold half unit (C4), two connecting plates (C5), a toggle mechanism (C6), a mold pressing hydraulic cylinder (C7), a connecting cross member (C8) and two shorter connecting rods (C9). The stationary mold half unit (C1) and the stationary wall (C2) are adapted to be fixed on the main body (A) of the molding machine and are spaced apart and are aligned with each other. Each of the longer connecting rods (C3) is connected securely and perpendicularly to one corner of the stationary mold half unit (C1) at one end and is connected securely to one corner of the stationary wall (C2) at the other end. The movable mold half unit (C4) is mounted movably on the connecting rods (C3) so as to be moved toward and away from the stationary mold half unit (C1) along the connecting rods (C3). The two connecting plates (C5) are disposed between the stationary wall (C2) and the movable mold half unit (C4). One of the connecting plates (C5) interconnects the upper two connecting rods (C3), while the other one of the connecting plates (C5) interconnects the lower two connecting rods (C3). The toggle mechanism (C6) is coupled with the stationary wall (C2) and the movable mold half unit (C4). The mold pressing hydraulic cylinder (C7) has a horizontal cylinder body which is connected to the stationary wall (C2) in such a manner that the outer end of the piston rod (C71) of the hydraulic cylinder (C7) can be activated hydraulically so as to move between the stationary wall (C2) and the connecting members (C5). One of the shorter connecting rods (C9) is disposed between the upper two connecting rods (C3) and interconnects the stationary wall (C2) and the upper one of the connecting plates (C5). The other one of the shorter connecting rods (C9) is disposed between the lower two connecting rods (C3) and interconnects the stationary wall (C2) and the lower one of the connecting plates (C5). The cross member (C8) is mounted movably on the connecting rods (C9) at the two vertical distal ends thereof and is coupled with the outer end of the piston rod (C71) at the center and with the toggle mechanism (C6) at the two horizontal distal ends thereof so as to be driven to activate the toggle mechanism (C6) in order to move the movable mold half unit (C4). Referring to FIG. 3, another type of mold pressing system (D) includes a stationary mold half unit (D1); a stationary wall (D2) which is aligned with the stationary mold half unit (D1) and which is spaced apart from the same; a number of connecting rods (D3), each of which is coupled with the stationary mold half unit (D1) at one end and with the stationary wall (D2) at the other end; a movable mold half unit (D4) mounted movably on the connecting rods (D3) so as to be moved toward and away from the stationary mold half unit (D1) along the connecting rods (D3); a toggle mechanism (D5) coupled with the movable mold half unit (D4) and the stationary wall (D2); and a mold pressing hydraulic cylinder (D6) having a cylinder body connected securely to the stationary wall (D2) and a piston rod coupled with the toggle mechanism (D5) in such a manner that the piston rod of the mold pressing hydraulic cylinder (D6) can be activated hydraulically to drive the toggle mechanism (D5) so as to move the movable mold half unit (D4).

Each of the toggle mechanisms (C6,D5) includes a plurality of members which are connected pivotally to each other by means of pivots (5,5'). When the piston rods (C71,D61) of the mold pressing hydraulic cylinders (C7,D6) are activated to drive the toggle mechanisms (C6,D5) so as to move the movable mold half unit (C4,D4) to press against the stationary mold half unit (C1,D1), the contact areas between the pivots (5,5') and the members suffer from a great action force, such as shearing and frictional force, due to the great pressure between the movable mold half unit (C4,D4) and the stationary mold half unit (C1,D1), thereby easily wearing the pivots (5,5'). If the pivots (5,5') are worn, the normal operation of the mold pressing system (C,D) will be affected. Furthermore, an inferior product will be produced. Therefore, most of the injection molding machines have a lubricating system provided thereon for lubricating the contact areas between the members and the pivots (5,5') of the toggle mechanism (C6,D5).

One kind of a lubricating system for lubricating the contact areas between the members and the pivots of the toggle mechanism includes a drip cup which has lubricating oil stored therein. The drip cup and the contact areas are joined together by oil passages so that the lubricating oil can drip naturally from the drip cup to the contact areas where lubrication is needed. The drawback of this lubricating system is that part of the contact areas, wherein the pivots and the members are in tight contact and/ or the contact areas are far away from the outlet of the oil passage, have no lubricating oil presented for lubrication due to the absence of a pressure which can force the lubricating oil to flow to these contact areas.

Another kind of a lubricating system includes a motor pump which can pump the lubricating oil to the contact areas through the oil passages, and an electric control box which is connected electrically to the motor pump so as to control the motor pump to force a predetermined amount of oil to those contact areas at a predetermined time interval (e.g. 100 c.c. of lubricating oil every 30 minutes). The drawback of this lubricating system is that it is very expensive. Furthermore, the pressure which is generated by the motor pump is insufficient to force a high-viscosity lubricating oil because of insufficient power. A large expense is necessary in order to acquire an adequate and powerful motor pump. Thus, the aforementioned problems in the preceding lubricating system cannot be overcome by this lubricating system due to the relatively low viscosity of the lubricating oil which was used and to the insufficient power of the

motor pump. Because of the low viscosity of the lubricating oil, the lubricating oil cannot flow into the tight contact areas even if the oil feeding time interval is minimized and/ or the amount of lubricating oil in one pumping action is increased. Furthermore, the excessive lubricating oil is wasted and can cause contamination problems.

SUMMARY OF THE INVENTION

Therefore, the main object of this invention is to provide a lubricating system for an injection molding machine, which lubricating system is efficient and relatively inexpensive.

According to this invention, a lubricating system is provided on a common injection molding machine, which machine includes a stationary mold half unit, a movable mold half unit which can be moved towards and away from the stationary mold half unit, a toggle mechanism coupled with the movable mold half unit so as to be driven to move the movable mold half unit towards and away from the stationary mold half unit, a mold pressing hydraulic cylinder having a piston rod coupled with the toggle mechanism so as to drive the toggle mechanism, and an oil feed system coupled with the mold pressing hydraulic cylinder so as to provide hydraulic pressure for the mold pressing hydraulic cylinder to drive the toggle mechanism. The lubricating system includes a pump driving hydraulic cylinder that is coupled with the oil feed system in such a manner that the pump driving hydraulic cylinder can be activated synchronously with the mold pressing hydraulic cylinder. The pump driving hydraulic cylinder has a cylinder body and a piston rod extending outward from the cylinder body. The piston rod has an outer end which can be moved toward and away from the cylinder body. An oil tank is provided to store lubricating oil therein. A lubricating oil pump has an oil inlet unit coupled with the oil tank and an oil outlet unit coupled with the toggle mechanism. The oil pump is coupled with the piston rod of the pump driving hydraulic cylinder. When the outer end of the piston rod of the pump driving hydraulic cylinder is moved toward the cylinder body of the pump driving hydraulic cylinder, the oil pump is activated to receive lubricating oil from the inlet unit. When the outer end of the piston rod of the pump driving hydraulic cylinder is moved away from the cylinder body of the pump driving hydraulic cylinder, the oil pump is activated to force lubricating oil from the oil pump to the toggle mechanism through the outlet unit so as to lubricate the toggle mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages of the present invention will become apparent in the following detailed description of the preferred embodiment, with reference to the accompanying drawings, of which:

FIG. 1 is a perspective view showing a common injection molding machine;

FIG. 2 is a perspective view of the mold pressing system of the common injection molding machine;

FIG. 3 is a perspective view showing the mold pressing system of another common injection molding machine; and,

FIG. 4 is a schematic diagram of the lubricating system for an injection molding machine according to this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 4, a lubricating system for a common injection molding machine according to this invention includes a pump driving hydraulic cylinder (2), a lubricating oil pump (3), an oil tank (4) for storing lubricating oil therein, and a pressure relief valve (6). The molding machine includes an oil feed system (1) and a mold pressing hydraulic cylinder (C7') which is arranged in the injection molding machine in the same manner as the cylinder (C7) (see FIG. 2) and which is coupled with the oil system (1).

The pump driving hydraulic cylinder (2) is coupled with the oil feed system (1) and the mold pressing hydraulic cylinder (C7') so that the oil feed system (1) provides a hydraulic pressure for the mold pressing hydraulic cylinder (C7') and the pump driving hydraulic cylinder (2) at the same time, thereby activating both of the hydraulic cylinders (C7',2). The pump driving hydraulic cylinder (2) has a piston rod (21) which extends outward from the stationary cylinder body thereof. The outer end of the piston rod (21) can be moved hydraulically toward and away from the cylinder body. The lubricating oil pump (3) is coupled with the outer end of the piston rod (21) of the pump driving hydraulic cylinder (2) so that the oil pump (3) is driven by the piston rod (21) of the pump driving hydraulic cylinder (2). The oil pump (3) has an oil inlet unit (31), which is communicated with the oil tank (4) so as to receive lubricating oil from the oil tank (4), and an oil outlet unit (32) which is communicated with the oil tank (4) via an oil conduit unit. The lubricating oil in the conduit unit is accessible to pivots (5") of the toggle mechanism of the injection molding machine.

The pressure relief valve (6) is coupled with the oil outlet unit (32) of the oil pump (3) and with the oil tank (4) so as to relieve excess pressure of the oil pump (3) and so as to permit recollection of excessive lubricating oil from the toggle mechanism into the oil tank (4).

Accordingly, when the piston rod (C71') of the mold pressing hydraulic cylinder (C7') is activated hydraulically by the oil feed system (1), the outer end of the piston rod (21) of the pump driving hydraulic cylinder (2) is activated synchronously by the oil feed system (1) to move toward the cylinder body of the pump driving hydraulic cylinder (2) so as to drive the oil pump (3) to receive oil from the oil tank (4) through the oil inlet (31). When the outer end of the piston rod (21) of the pump driving hydraulic cylinder (2) is moved away from the cylinder body, the pump (3) is driven to force the lubricating oil to flow to the pivots (5") through the oil outlet unit (32). Thus, the pivots (5") are lubricated in every operation of the toggle mechanism of the molding machine, and the pump (3) has a sufficient power to force a high-viscosity lubricating oil to the tight contact areas between the pivots (5") and the members of the toggle mechanism of the mold machine. If the oil pump (3) is overpressurized by the pump driving hydraulic cylinder (2) and forces excessive lubricating oil to the contact areas, the pressure relief valve (6) can relieve the overpressure of the oil pump (3) and can permit the recollection of the excessive lubricating oil from the toggle mechanism into the oil tank (4).

While the present invention has been described in connection with what is considered the most practical and preferred embodiment, it is understood that this invention is not limited to the disclosed embodiment,

but is intended to cover various arrangements included within the spirit and scope of the broadest interpretation so as to encompass all such modifications and equivalent arrangements.

I claim:

1. An injection molding machine, said injection molding machine including a stationary mold half unit, a movable mold half unit which can be moved towards and away from said stationary mold half unit, a toggle mechanism coupled with said movable mold half unit so as to be driven to move said movable mold half unit towards and away from said stationary mold half unit, a mold pressing hydraulic cylinder having a piston rod coupled with said toggle mechanism so as to drive said toggle mechanism, an oil feed system coupled with said mold pressing hydraulic cylinder so as to provide hydraulic pressure for said mold pressing hydraulic cylinder to drive said toggle mechanism, and a lubricating system said lubricating system comprising:

a pump driving hydraulic cylinder coupled with said oil feed system in such a manner that said pump driving hydraulic cylinder can be activated synchronously with said mold pressing hydraulic cylinder, said pump driving hydraulic cylinder having a cylinder body and a piston rod extending outward from said cylinder body, said piston rod having an outer end which can be moved hydraulically toward and away from said cylinder body;

an oil tank for storing lubricating oil; and

a lubricating oil pump having an oil inlet unit coupled with said oil tank and an oil outlet unit coupled with said toggle mechanism, said oil pump being coupled with said piston rod of said pump driving hydraulic cylinder; whereby, when said outer end of said piston rod of said pump driving hydraulic cylinder is moved toward said cylinder body of said pump driving hydraulic cylinder, said oil pump is activated to receive lubricating oil through said inlet unit; when said outer end of said piston rod of said pump driving hydraulic cylinder is moved away from said cylinder body of said pump driving hydraulic cylinder, said oil pump is activated to force lubricating oil from said oil pump to said toggle mechanism through said outlet unit so as to lubricate said toggle mechanism.

2. The injection molding machine as claimed in claim 1, further comprising a pressure relief valve coupled with said outlet of said oil pump and said oil tank so as to relieve overpressure of said oil pump and so as to permit recollection of excessive lubricating oil from said toggle mechanism into said oil tank.

* * * * *